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OCTOBER 1949

PUBLISHED MONTHLY BY AMERICAN MEDICAL ASSOCIATION, 535 NORTH DEARBORN STREET, CHICAGO 10, ILLINOIS. ANNUAL SUBSCRIPTION, $10.00

Entered as Second Class Matter July 10, 1925, at the Postoffice at Chicago, Under the Act of Congress of March 3, 1879

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CONTENTS OF PREVIOUS NUMBER

SEPTEMBER 1949. NUMBER 3

Origins of the National and Regional Surgical Societies: Presidential Address. Henry K. Ransom, M.D., Ann Arbor, Mich.

Pharyngeal Neurilemmomas of Cranial Nerve Origin: Medial Displacement of the Internal Carotid Artery as a Diagnostic Sign. Danely P. Slaughter, M.D., and Frederic A. de Peyster, M.D., Chicago.

Treatment of the "Shock Kidney." John K. Ormond, M.D., and Milton E. Klinger, M.D., Detroit.

Transplantation of the Spinal Cord for Paraplegia Secondary to Pott's Disease of the Spinal Column. J. Grafton Love, M.D., and Howard R. Erb, M.D., Rochester, Minn.

Epithelioma of the Lower Lip: Evaluation of Dissection of Cervical Lymph Nodes. Edward S. Judd Jr., M.D., and Oliver H. Beahrs, M.D., Rochester, Minn.

Nonobstructive Lateral Portal Vein–Vena Cava Anastomosis: A Clinical Application of the Smith Freeman Clamp. Ormand C. Julian, M.D., and William Metcalf, M.D., Chicago.

Sterility and Endometriosis. Leon S. McGoogan, M.D., Omaha.

Surgical Treatment of Tricuspid Atresia. Egbert H. Fell, M.D.; Benjamin M. Gasul, M.D.; Carl B. Davis Jr., M.D., and Raul Casas, M.D., Chicago.

Tracheoesophageal Fistula Caused by Blunt Violence. R. W. Albi, M.D., and R. K. Glichrist, M.D., Chicago.

An Extravesical Method for the Relief of Vesical Occlusion. Robert Lich Jr., M.D.; Joseph E. Maurer, M.D., and Stephen Burdon, M.D., Louisville, Ky.

Surgical Management of Respiratory Emergencies During the First Few Weeks of Life. Leon J. Leahy, M.D., and Winfield L. Butsch, M.D., Buffalo.

Surgical Management of Omphalocele. Charles Hugh Maguire, M.D., Louisville, Ky.

New Surgical Procedures in Certain Cases of Congenital Pulmonary Stenosis. Willis J. Potts, M.D., and Sidney Smith, M.D., Chicago.

A Method for Control of Bleeding from Esophageal Varices. Thomas B. Patton, M.D., and Charles G. Johnston, M.D., Detroit.

Experiences with Islet Cell Tumors. Roy D. McClure, M.D., and Brock E. Brush, M.D., Detroit.

Appendicitis: A Ten Year Survey; 1935 Through 1944. E. T. Thieme, M.D., Ann Arbor, Mich.

Tetraethylammonium Chloride in Experimental Vascular Injuries of Limb, Bowel and Heart. Edward J. Hill, M.D.; John M. Hammer, M.D.; Harry C. Saltzstein, M.D., and Clifford D. Benson, M.D., Detroit.

Effect of Distention on Intestinal Revascularization. Rudolf J. Noer, M.D., and John William Derr, M.D., Detroit.

Observations in Strangulation Obstruction: II. The Fate of Sterile Devascularized Intestine in the Peritoneal Cavity. Harold Laufman, M.D., Ph.D.; Wayne B. Martin, M.D.; Harold Method, M.D.; Stanley W. Tuell, M.D., and Harry Harding, M.D., Chicago.

Use of an Abdominal Flap Graft in Construction of a Permanent Ileostomy. Clarence W. Monroe, M.D., and John H. Olwin, M.D., Chicago.

Varicosities of the Lesser Saphenous Vein. Walter W. Carroll, M.D., Chicago.

Substitution of the Urinary Bladder with an Isolated Segment of Sigmoid Colon. J. Dewey Bisgard, M.D., and H. Harper Kerr, M.D., Omaha.

Reduction in Mortality and Loss of Limbs in Diabetic Gangrene and Infection. J. Sutton Regan, M.D.; Byron D. Bowen, M.D., and Paul A. Fernbach, M.D., Buffalo.

Prompt Postoperative Activity After Herniaplasty: Its Influence on Incidence of Complications and Rate of Recurrence. John H. Powers, M.D., Cooperstown, N. Y.

Prevention and Management of Thromboembolism. Richard H. Lillie, M.D.; Robert W. Buxton, M.D., and Ivan F. Duff, M.D., Ann Arbor, Mich.

Early and Late Sequelae of Therapeutic Vein Ligation for Thrombosis of Veins of Lower Limbs. D. Emerick Szilagyi, M.D., and Joseph F. Alsop, M.D., Detroit.

Intravascular Agglutination (Sludged Blood), Vascular Stasis and Sedimentation Rate of the Blood in Trauma. W. G. Bigelow, M.D.; R. O. Heimbecker, M.D., and R. C. Harrison, M.D., Toronto, Canada.

Biopsy of Diffuse Pulmonary Lesions. Karl P. Klassen, M.D.; Alexander J. Anlyan, M.D., and George M. Curtis, M.D., Columbus, Ohio.

Use of Polyethylene in Extrapleural Pneumonolysis. William B. Condon, M.D., and Fred R. Harper, M.D., Denver.

"Spontaneous" Rupture of the Esophagus. Campbell McGregor Gardner, M.D., C.M., F.R.C.S. (Eng.), F.R.C.S. (C.), Montreal, Canada.

Intravenous Administration of Procaine Hydrochloride During General Anesthesia. Ivan B. Taylor, M.D.; Bert W. Marks, M.D., and Gerald Edmunds, M.D., Detroit.

Surgical Treatment of Low Back Pain with Sciatic Radiation: Preliminary Report on Three Hundred and Forty-Six Cases. Albert S. Crawford, M.D.; C. Leslie Mitchell, M.D., and George R. Granger, M.D., Detroit.

Postoperative Management of Patients Undergoing Transthoracic Gastroesophageal Operations. Charles B. Puestow, M.D.; Max S. Sadove, M.D., and Charles Allison, M.D., Chicago.

Gangrenous Perforation of the Gallbladder: Analysis of Nineteen Cases. Willis G. Diffenbaugh, M.D.; Francis E. Sarver, M.D., and E. Lee Strohl, M.D., Chicago.

Adequate Subtotal Gastric Resection for Duodenal Ulcer. R. H. La Bree, M.D., and M. G. Gillespie, M.D., Duluth, Minn.

Von Haberer–Finney Gastrectomy with Vagotomy. Lawrence S. Fallis, M.D., and James Barron, M.D., Detroit.

Precautions and Results in Gastrectomy. Ward H. Eastman, M.D., and Warren H. Cole, M.D., Chicago.

Blood Transfusion and Reaction in Surgical Patients. Thomas H. Seldon, M.D., and John E. Osborn, M.D., Rochester, Minn.

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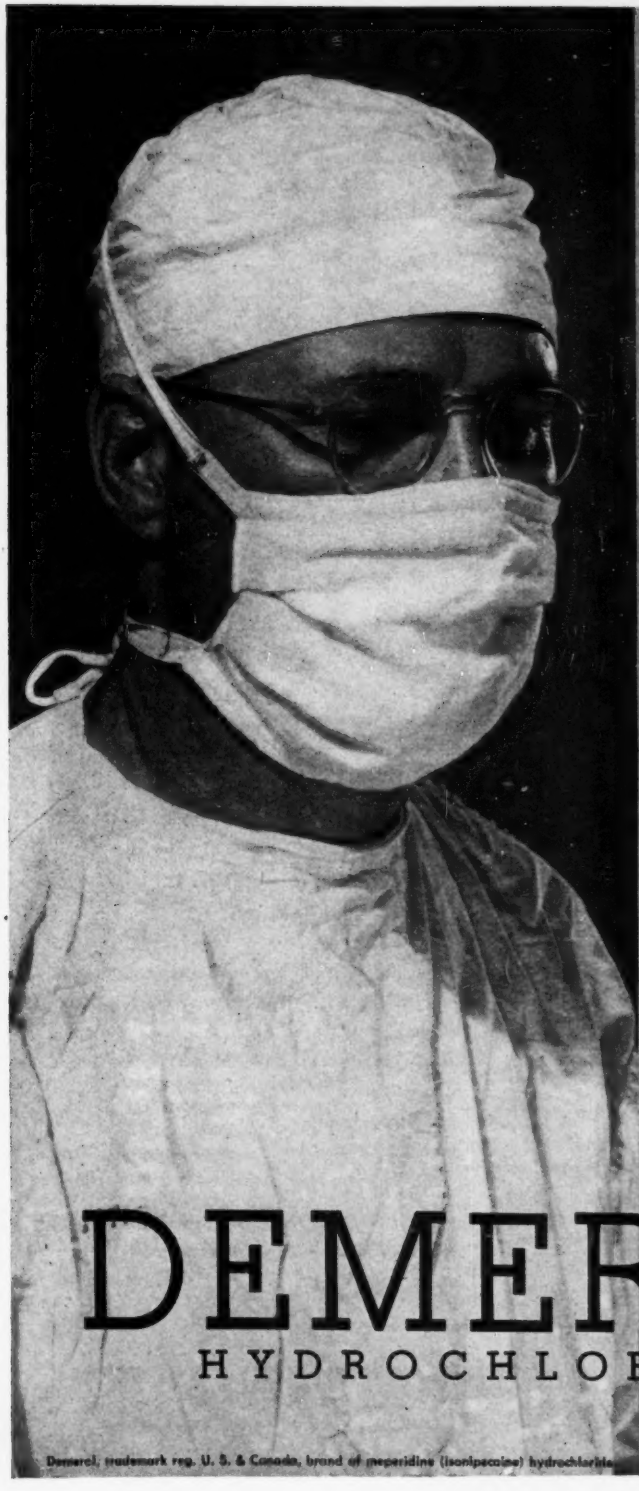

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RETROGRADE SPREAD OF CARCINOMA IN THE RECTUM AND RECTOSIGMOID

JAMES F. CONNELL Jr., M.D.
AND
ANTONIO ROTTINO, M.D.
NEW YORK

SINCE knowledge concerning the frequency, extent and nature of retrograde spread [1] of carcinoma in the rectosigmoid and rectum is still incomplete, many surgeons are uncertain of the surgical procedures offering the most promise to the patient. However, those surgeons who are most radical in their practice point to a lesser number of recurrences in patients so treated when compared to those who have been less radically treated. The question therefore arises of whether increased incidence of recurrence in the less radically treated patients may not be due to preoperative retrograde spread from the portion of the bowel removed to the portion left behind.

Attempts to answer this question appeared in the literature of 1913 and 1914.[2] It was shown that in approximately 20 specimens retrograde spread occurred from 1 to 2 cm. below the lesion. However, the method of study was inadequate since examination was limited to a strip of bowel 1 cm. wide and 20 cm. long cut into approximately twenty 1 cm. blocks, from each of which one section had been cut for microscopic examination.

During the next twenty-five years investigators [3] dissected lymph nodes below the primary lesion and sectioned them serially. Of 607 specimens thus examined retrograde spread was observed in 45. Five of these 45 showed tumor from 2 to 7 cm. below the lesion. The

From St. Vincent's Hospital.

1. We are using the term "retrograde spread" in the sense of the tumor spreading from the primary lesion down in the direction of the anal canal within the wall of the bowel or into immediately adjacent lymph nodes.

2. Cole, P. P.: Brit. M. J. **1**:431-433, 1913. Monsarrat, K. W., and Williams, I. J.: Brit. J. Surg. **1**:173-182, 1913. Cheatle, G. L.: Brit. M. J. **1**:303, 1914.

3. Coller, F. A.; Kay, E. B., and MacIntyre, R. S.: Surgery **8**:294-311, 1940. Dixon, C. F.: Am. J. Surg. **46**:12-17, 1945. Gilchrist, R. K., and David, V. C.: Ann. Surg. **108**:621-642, 1938. Glover, R. P., and Waugh, J. M.: Surg., Gynec. & Obst. **82**:434-448, 1946. ibid. **82**:438, 1946. Grinnell, R. S.: Ann. Surg. **116**: 200-216, 1942.

Clinical and Pathologic Data on 9 Cases

Case No.	1153	S-650	A-2545	S-2131	S-2128	S-1836	S-1999	S-1830	S-1783
Duration clinically, months	3	5	?	4	12	4	3	4	3
Site of main lesion	Anterior right lateral wall	Posterior wall	Anterior wall	Anterior lateral wall	Anterior wall	Left anterior wall	Posterior wall	Posterior wall, sacrum	Posterior wall
Distance above anal ring, cm.	8.5	2	20	11	7.6	11	10.5	6	7
Size	2 × 1 cm.	5 × 4.2 cm.	6 × 2.6 cm.	5.4 × 4 cm.	6 × 6 cm.	4 × 4 cm.	4.2 × 4.8 cm.	6 cm. long 2 × 2 cm.	4 × 6 cm.
Distance short of complete encir clement, cm.	4	1.6	1.8	1.4	1.8	1.2	0.8	0	4.4
Miscroscopic appearance	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma with mucoid degeneration	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma
Group	C	C	C	C	B	C	C	C	C
Multiple lesions	0	0	Benign papilloma	0	Duke C tumor,* 5.2 cm. downward	0	0	0	0
Downward extension	Direct extension,* 3 cm.; node, 7 cm.	0	4.5 cm.*	0	0	0	0	Direct extension,* 6 cm.	0
Peritoneal invasion	0	0	Present	0	0	0	0	0	0
Levator ani	0	0	0	0	0	0	0	Present	0
Preaortic node	0	0	0	0	0	0	0	0	0
Liver	One small nodule seen	0	0	0	0	0	0	0	0
Lungs	0	0	0	0	0	0	0	0	0
Number of sections	200	40	200	200	170	520	170	40	220

* See figures 1, 2, 3 and 4.

inadequacy of this second method is obvious, since there was no thorough examination of the wall of the bowel itself. We therefore attempted to secure a more complete examination by using a serial section method which embraced the entire circumference of the wall of the bowel. It is the result of this study which we wish to present.

In the accompanying table the essential clinical and pathologic data are condensed.

Nine specimens were studied. Eight were obtained at operation and 1 at autopsy. These were photographed, measured and then drawn to scale. After fixation in 4 per cent formaldehyde the whole bowel was sectioned transversely from the lower margin of the tumor to the upper level of the anal ring, in approximately 0.5 cm. blocks. A single microscopic section, made from the proximal surface of each block, served to screen the various levels for tumor. Specimen 1836, the first to be studied in this series, was cut 5 microns in thickness at 100 micron intervals. All subsequent specimens were cut at 250 micron intervals unless screening exhibited involvement, in which instances sections were cut at 100 micron intervals. One thousand, eight hundred slides were thus prepared.

RESULT OF STUDY

All tumors were ulcerated, cylindric cell adenocarcinomas. One showed colloid degeneration. Eight were classified as Duke C tumors and one as a Duke B tumor (see table).

In 5 specimens there was no retrograde spread. One specimen showed retrograde extension for 6.4 cm. below the main lesion (case 3). Another specimen was seen to have a second tumor of microscopic size 6 cm. below the main lesion. In 2 others there was extensive retrograde involvement of lymph channels and lymph nodes for significant distances below the primary lesion.

CASE 1 (no. 1153).—A man aged 63 had symptoms for three months. A tumor was found 8.5 cm. above the anal ring, encircling all but 4 cm. of the total circumference. It was adenocarcinoma, Duke C. Serial section revealed narrow columns of tumor extending below the main tumor for 3.4 cm. within the submucosa and muscularis. This downward extension was not grossly detectable, the mucosa covering it being intact. In addition to this, numerous lymph channels of the submucosa, muscularis and serosa, distended with tumor, were found as low as 7 cm. from the inferior margin of the primary lesion (fig. 1).

CASE 2 (no. 2545).—The patient was a man aged 76. The duration of his disease was unknown. A carcinoma which involved all but 1.8 cm. of the circumference was found 20 cm. above the anal ring. Microscopic examination proved it to be a cylindric cell adenocarcinoma with colloid degeneration. Study of the serial sections revealed many tumor nodules of microscopic size in the adventitia, scattered downward for a distance of 4.2 cm. below the inferior

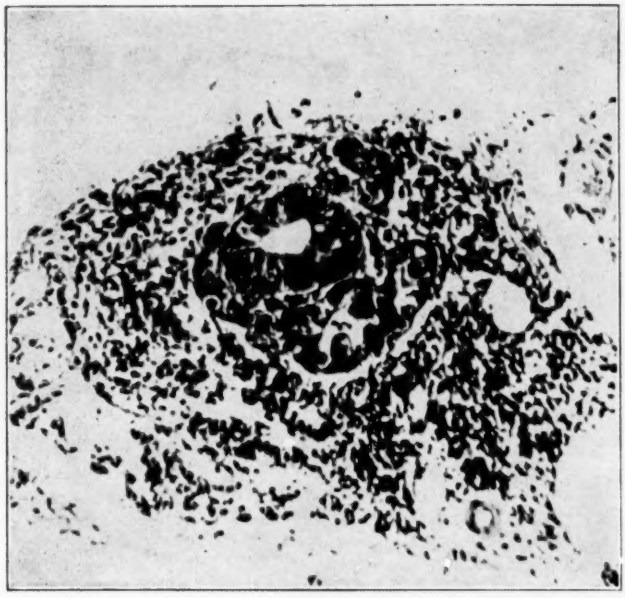

Fig. 1 (case 1).—Lymph channels lying within the intermuscular connective tissue are filled with tumor. (Level is 5 cm. below the inferior border of the main lesion.)

Fig. 2 (case 2).—Lymph channels in the serosa are distended with malignant cells. These were found as low as 4.2 cm. below the inferior margin of the main lesion.

margin of the primary lesion (fig. 2). There were in addition many tumor-distended lymph channels in the submucosa, muscularis and adventitia.

CASE 3 (no. 1830).—The patient was a man aged 76. The tumor occupied the entire circumference of the wall of the bowel in the rectum 6 cm. above the

Fig. 3 (case 3).—Tumor infiltration in the submucosa extending down for a distance of 4.1 cm.

anal ring. It was an adenocarcinoma, Duke C. Study of the serial sections revealed a 2 cm. wide direct extension downward from the inferior margin of

the main lesion for a distance of 4.1 cm. The area of extension lay entirely within the submucosa and muscularis (fig. 3). Lymph nodes and lymph channels subjacent to this narrow zone of extension were involved by tumor. Many hyperplastic lymph nodes were noted below the main tumor. Below the main tumor and lateral to the retrograde extension many hyperplastic lymph nodes were noted, but none was involved by metastasis.

CASE 4 (no. 2128).—The patient was a woman aged 60. The rectal tumor was found on the anterior wall 7.6 cm. above the anal ring and fell 1.8 cm. short

Fig. 4 (case 4).—Lymph channel in the tunica propria filled with carcinoma. Lymph channels such as these were found between the two tumors. None was found below the small tumor.

of completely encircling the wall of the bowel. Microscopically it proved to be adenocarcinoma, Duke B. On study of serial sections, a small tumor 3 by 2 mm. was found in the mucosa 5.2 cm. below the large primary tumor. It was an adenocarcinoma. Many lymph channels in all layers of the wall of the bowel between the large and the small tumor were filled with tumor cells (fig. 4). Serial section below the second microscopic tumor failed to show retrograde spread.

COMMENT

Although the total number of cases in the present study is small, it nevertheless shows that in cases of moderately advanced carcinoma of the rectum retrograde spread is common. Demonstration of this fact, however, proved laborious since serial section was necessary. It is not our purpose to establish case 4 as an example of multiple primary carcinoma of the rectum. Of greater significance is the fact of its presence. It would be of interest to know how often this circumstance might be found if a large series of specimens were studied by our method.

An attempt to correlate duration of symptoms with presence or absence of retrograde spread would be interesting, but the small number of our cases would make conclusions precarious. Suffice it to say that in 1 instance of retrograde spread symptoms were present for three months and in another case for twelve months.

Since we were primarily interested in spread downward we did not section the bowel above the site of the tumor as carefully as we did that below the tumor; hence we are not in a position to state categorically that retrograde spread was or was not related to complete block of lymph channels in the forward position.

We feel that our findings support the surgeons who use radical procedures. Though our conclusion is based on a relatively small number of cases, it is nevertheless worthy of consideration because of the complete and laborious examination of the material.

EARLY AND DELAYED CLINICAL EFFECTS OF VAGOTOMY FOR PEPTIC ULCER

CHARLES S. KIPEN, M.D.
AND
G. ARNOLD STEVENS, M.D.
BEVERLY HILLS, CALIF.

BETWEEN Nov. 1, 1946 and Nov. 1, 1947, vagus resection for treatment of peptic ulcer, as recently advocated by Dragstedt,[1] was performed in 42 cases at the Veterans Administration General Hospital at Los Angeles (Sawtelle), Calif. All patients were operated on by surgeons of the joint graduate teaching service of the University of Southern California, College of Medical Evangelists, and the University of California at Los Angeles medical schools. The patients, all men, varied in age from 20 to 68 years, the average age being 47½ years. One or more of the classic indications for surgical intervention in treatment of peptic ulcer were present in all cases, namely, (1) chronicity with poor response to, or inability to carry out, an adequate medical regimen, (2) hemorrhage and (3) obstruction. The duration of symptoms varied from four months to twenty years, the average being 11.2 years. Recurrent or intractable pain was a prominent feature in the majority of these cases. Hemorrhage, as determined by a history of hematemesis or melena, was present in 16 cases, together with other symptoms, but did not in itself constitute an indication for vagus resection in this series. Obstruction, as determined by retention of barium after six hours during roentgenologic study, was present in 8 cases. Twenty-four patients had undergone previous operation for treatment of peptic ulcer. These

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Dr. Kipen is in the department of surgery at the United States Veterans Administration General Hospital, Los Angeles, and Dr. Stevens consultant in surgery at that hospital and associate clinical professor of surgery, University of California at Los Angeles.

1. (*a*) Dragstedt, L. R., and Owens, F. M.: Supradiaphragmatic Section of Vagus Nerves in Treatment of Duodenal Ulcer, Proc. Soc. Exper. Biol. & Med. **53**:152-154, 1943. (*b*) Dragstedt, L. R., and Schafer, P. W.: Removal of the Vagus Innervation of the Stomach in Gastroduodenal Ulcer, Surgery **17**:742-749, 1945. (*c*) Dragstedt, L. R.: Vagotomy for Gastroduodenal Ulcer, Ann. Surg. **122**:973-989, 1945.

included 15 patients with perforation treated by simple closure, 7 who had undergone previous gastroenterostomy and 3 who had been subjected to previous partial gastrectomy. Four patients had undergone multiple previous operative procedures; perforation had occurred twice in 2, and 2 others had been subjected to repair of perforation followed at a later date by gastroenterostomy.

In this series, transthoracic vagus resection was done in 9 cases, abdominal vagotomy without any complementary procedure in 13 cases, vagotomy plus gastroenterostomy in 14 cases and vagotomy plus subtotal gastric resection in 6 cases. There was no apparent indication for the particular type of approach or procedure with the exception that complementary gastroenterostomy or gastrectomy was performed in each of the 8 patients who showed preoperative evidence of pyloric obstruction. Table 1 summarizes the data on all vagus resections done at this institution from Nov. 1, 1946 to Nov. 1, 1947.

TABLE 1.—*Data on Resection of Vagus Nerve Done from Nov. 1, 1946, to Nov. 1, 1947*

Type of Operation	Number of Cases	Duodenal Ulcer	Gastric Ulcer	Gastrojejunal Ulcer
(1) Vagus resection only				
(a) Transthoracic	9	5	0	4
(b) Abdominal	13	6	1	6
Total	22	11	1	10
(2) Vagus resection plus gastroenterostomy	14	14	0	0
(3) Vagus resection plus partial gastrectomy	6	6	0	0
Total number of cases	42	31	1	10

EARLY POSTOPERATIVE STUDIES

The early postoperative course of these patients was followed prior to their discharge from the hospital with regard to subjective relief of symptoms of ulcer, the effect on gastric acidity and the incidence of disturbance of gastrointestinal motility as shown by clinical and roentgenologic evidence. All cases in this series were included in the early postoperative studies except for one in which operative death occurred (case 13) which was directly attributable to mediastinitis following a perforation of the esophagus in an attempt to isolate the vagi subdiaphragmatically. The vagi were found at autopsy to be deeply embedded in the esophageal musculature.

A. Subjective Results.—In the remaining 41 cases there was a rather striking subjective result. Relief of pain was obtained in all cases except 2, and in all fairness to the procedure it should be stated that both of these patients had overt psychoneurosis, which made subjective evaluation difficult, particularly in view of the fact that they were among the few in whom definite roentgen evidence of healing of the ulcer was apparent. Twenty-two, or 52 per cent, of the patients

had a benign postoperative course, with no immediately recognizable evidence of gastrointestinal atonia, sphincter achalasia or diarrhea and no subjective complaints. These patients were able to leave the hospital completely asymptomatic and on an unrestricted diet.

The remaining 48 per cent of the cases were complicated by troublesome symptoms of impaired gastric motility or other immediate untoward complications.

In addition to severe symptoms of gastric atonia as complications in 2 cases, dysphagia with roentgenologic evidence of esophageal achalasia occurred in 2 patients in conjunction with gastric atonia and was troublesome for two and four weeks respectively. Other complications included persistent diarrhea lasting for two months with spontaneous remission in 1 case. Intestinal obstruction secondary to previous operative adhesions occurred in another case, necessitating a second laparotomy, after which further convalescence was uneventful. Paralytic ileus complicated still another case but responded well to conservative treatment. Other complications, not necessarily related to vagus resection per se, included postoperative abscess of the lung in 1 case, atelectasis in 1 case and severe chemical imbalance consisting essentially of severe alkalosis and hypochloremia, probably secondary to prolonged gastric suction without adequate chloride replacement, in another case.

At the time of the patients' discharge from the hospital, 5 cases in the entire series could be interpreted as showing a poor subjective result. The patients involved included the 2 previously mentioned who did not experience relief of pain, 2 others in whom troublesome symptoms of impaired gastric motility persisted and another patient in whom one vagus nerve was definitely known not to have been severed and whose subjective relief was equivocal. These 5 cases plus the operative death constitute a subjective failure of 15 per cent for the entire series. This is in agreement with an incidence of good subjective results in 87 per cent of a series of 75 patients reported by Moore.[2] The remaining patients all left the hospital on an unrestricted diet and with no symptoms referable to their ulcer.

B. Studies of Gastric Acidity.—Studies of gastric acidity in these patients bear out the results of other observers (Moore and others and Grimson and his associates[3]) in that gastric acidity was significantly

2. Moore, F. D.: Resection of the Vagus Nerves for Ulcer: An Interim Evaluation, Arch. Surg. **55**:164-174 (Aug.) 1947.

3. Moore, F. D.; Chapman, W. P.; Schulz, M. D., and Jones, C. M.: Transdiaphragmatic Resection of the Vagus Nerves for Peptic Ulcer, New England J. Med. **234**:241-251, 1946; Vagus Resection in Peptic Ulcer: Physiologic Effects and Clinical Results, J. A. M. A. **133**:741-759 (March 15) 1947. Grimson, K. S.; Baylin, G. J.; Taylor, H. M.; Hesser, F. H., and Rundles, R. W.: Transthoracic Vagotomy: The Effects in Fifty-Seven Patients with Peptic Ulcer and the Clinical Limitations, ibid. **134**:925-932 (July 12) 1947.

reduced after vagus resection. Studies of the night secretion and the response to histamine and insulin-induced hypoglycemia were done in the majority of cases. The mean results of these studies as expressed in maximum degrees of free acid is illustrated in table 2. Interestingly, we have found in our preoperative studies of gastric acidity that the patients with a history of perforation have almost consistently had the highest amounts of night secretion and the highest degree of acidity as well as a more marked response to insulin-induced hypoglycemia. This observation deserves further study as it may indicate a possible relationship between the degree of gastric acidity and the tendency to perforation.

It is readily noted that a decided reduction in the response to insulin-induced hypoglycemia is the most striking feature following vagus resection, with a drop of 83 per cent in the maximum acid

TABLE 2.—*Preoperative and Postoperative Gastric Acidity Following Resection of Vagus Nerve*

		Preoperative			Postoperative		
Operation	Number of Cases Studied	Histamine (Maximum Degrees of Free Acid, Mean Values)	Insulin (Maximum Degrees of Free Acid, Mean Values)	Night Secretion, Amount/ Degree Acidity (Mean Values)	Histamine (Maximum Degrees of Free Acid, Mean Values)	Insulin (Maximum Degrees of Free Acid, Mean Values)	Night Secretion, Amount/ Degree Acidity (Mean Values)
Vagotomy only for duodenal ulcer	12	66.6	83.7	700/20	51	13	247/10.5
Vagotomy for stomal ulcer	8	38	61	815/9	10	7.5	350/9
Vagotomy plus resection or anastomosis	19	52.4	64	777/37	45	13.8	530/2
Totals	39	52.3	69.5	764/22	35.3	11.4	376/7

response, from 69.5 degrees preoperatively to 11.4 degrees postoperatively, representing the mean values for the entire series. There is also noted an approximate 50 per cent reduction in the night secretion, whereas the histamine response is the least altered by comparison, with a reduction of approximately 30 per cent. This is at variance with the findings of Crandell and others [4] and of Thornton, Storer and Dragstedt,[5] who found no reduction in acidity with histamine stimulation after transthoracic resection of the vagus nerves. There is no significant difference in reduction of gastric acidity in cases in which resection or gastroenterostomy had been carried out prior to or at the time of vagotomy as compared with cases in which simple vagotomy was per-

4. Crandell, W. B.; Boehm, W. E., and Mulholland, J. H.: Effects of Supradiaphragmatic Section of the Vagus Nerves in Man, Arch. Surg. **55**:343-348 (Sept.) 1947.

5. Thornton, T. F., Jr.; Storer, E. H., and Dragstedt, L. R.: Supradiaphragmatic Section of the Vagus Nerves: Effect on Gastric Secretion and Motility in Patients with Peptic Ulcer, J. A. M. A. **130**:764-771 (March 23) 1946.

formed. Twenty-one patients in the entire series showed a complete absence of free acid in fasting specimens postoperatively.

Individually considered, however, there was only 1 patient in whom failure to obtain a significant reduction in night secretion and/or insulin response was encountered. He, however, had undergone a simultaneous gastroenterostomy, and the excellent clinical response obtained may have been due entirely to the latter procedure. Similarly, in 4 cases in which one or both vagi were not obtained, as evidenced by failure to find nerve tissue by histologic study in the excised specimens, the studies of postoperative acidity showed a satisfactory reduction. However, all 4 of the patients had undergone simultaneous gastroenterostomy or gastric resection, which indicates what is obviously true, namely, that proper evaluation of vagus resection cannot be made when simultaneous complementary procedures are done which in themselves may cause lowered gastric acidity and relief of symptoms of ulcer.

C. Roentgenologic Studies.—Evidence of gastric retention as shown by considerable gastric residue of barium after six hours was shown in

TABLE 3.—*Roentgenologic Evidence of Gastric Retention (Early Postoperative)*

	Number of Cases Studied	Evidence of Retention After 6 Hours	Incidence, Percentage
Vagotomy alone	9	7	78
Vagotomy for marginal ulcer	6	2	33
Vagotomy plus resection or anastomosis	9	3	33
Totals	24	12	50

48 per cent of 24 patients who were given postoperative roentgenologic examinations. Roentgenologic studies were otherwise generally inconclusive, since most of the patients who showed duodenal deformity preoperatively showed roentgen evidence of continued deformity postoperatively. What could be interpreted as healing of the ulcer in the roentgenogram occurred in 8 cases. It is obvious, of course, that the interpretation of healing roentgenologically must of necessity eliminate the cases in which complementary gastrectomy was done and that the duodenal ulcer will probably not be visualized in most of the cases in which complementary gastroenterostomy was performed. There remain only 12 cases in which preoperative and postoperative roentgen studies were available. Of the 12 patients, 7, or 58.3 per cent, showed evidence of actual disappearance of an active ulcer crater, although deformity persisted. These included 3 patients with duodenal ulcer and 3 with stomal ulcer. In the patient with gastric ulcer there was complete healing on roentgen study two weeks postoperatively.

Table 3 indicates the roentgenologic incidence of gastric retention as evidenced by residual barium in the stomach estimated at 25 per cent

or over after six hours. In 24 cases in which postoperative roentgenograms were made the total incidence of this complication was 50 per cent. With vagotomy alone, evidence of retention was observed in 7 of 9 cases, or 78 per cent.

FOLLOW-UP STUDIES

In order to valuate the procedure in the light of late results, all patients for whom at least three months had elapsed since operation were requested to return to the hospital for examination or to reply to a questionnaire relative to their symptoms. We were thus able to study

TABLE 4.—*Roentgenologic Studies in Cases of Vagotomy Only*

Case	Early Postoperative	Months Since Operation	Follow-Up
1	Large gastric residue after 24 hours	10	70 per cent retention after 24 hours; possible prepyloric ulcer
5	Duodenal ulcer deformity and crater with 25 per cent retention after 6 hours	11	Old duodenal ulcer deformity with 30 per cent retention at 6 hours
6	Esophageal achalasia and 25 per cent gastric retention after 6 hours	6	Dilated stomach with 50 per cent residual after 6 hours
7	Duodenal ulcer deformity with disappearance of crater; 50 per cent gastric retention after 6 hours	11	85 per cent retention at 30 hours; stomach empty at 48 hours
11	Duodenal deformity; almost complete gastric retention at 6 hours	10	70 per cent retention at 24 hours; stomach empty in 48 hours
14	Duodenal scarring, 40 per cent gastric retention at 6 hours; esophageal achalasia	9	40 per cent gastric retention after 24 hours
38	.....	3	40 per cent gastric retention after 24 hours
12	Gastric ulcer healed within 2 weeks; no disturbance of motility	..	.....
21	50 per cent retention	3	No retention
29	Ulcer healed by roentgenogram; no retention	3	No retention

a total of 25 patients at intervals varying from three to twelve months after operation. These included 10 of the 12 patients in whom resection of the vagus nerve only was done, 11 of the 20 patients who underwent such resection plus a complementary procedure and 5 of the 10 patients operated on for marginal ulcer.

A. Vagotomy Only.—In this group we were able to obtain roentgenologic studies on 9 patients, as shown in table 4. It is readily noted that only 2 of the patients who had shown evidence of early postoperative gastric retention showed no retention in the follow-up studies (cases 14 and 21). Six patients showed either a persistence of retention or even more pronounced evidence of it than was observed on their early postoperative roentgenograms, 4 of them failing to show com-

plete gastric emptying after twenty-four hours and 3 of these showing retained barium estimated at 70 per cent or over. These studies indicate a late incidence of gastric retention of 78 per cent from three to eleven months after operation, which is identical with the early postoperative incidence after vagotomy alone as noted in table 3. Table 5 summarizes the follow-up roentgen evidence of gastric retention for the entire series.

Follow-up studies of gastric acidity were obtained after simple vagotomy in 6 of these patients who consented to return to the hospital for such studies. A comparison of the mean values for gastric acidity in the early and the late postoperative studies is indicated in table 6.

It is seen that the night secretion remained constant, although there is a small rise in the mean response to insulin in the later post-

TABLE 5.—*Late Postoperative Roentgenologic Evidence of Gastric Retention*

	Number of Cases Studied	Evidence of Retention After 6 Hours	Incidence, Percentage
Vagotomy alone	9	7	78
Vagotomy for marginal ulcer	4	1 (slight)	25 (?)
Vagotomy plus resection	3	0	0
Vagotomy plus gastroenterostomy	5	3	60
Totals	21	11	52

TABLE 6.—*Gastric Acidity*

	Number of Cases	Histamine (Maximum Degrees of Free Acid)	Insulin (Maximum Degrees of Free Acid)	Night Secretion, Cc./Degree
Early postoperative studies	12	51	13	247/10.5
Late postoperative studies	6	30	22.5	241/10.8

operative studies. Although this rise is probably too small to be of great significance at the present time, it is of interest in the light of experimental resection of the vagus nerve in dogs in which it has been shown by Vanzant [6] that gastric acidity will return to preoperative levels in about two years.

Subjective follow-up studies were obtained in 10 of the 12 cases with regard to symptomatic results. One of the patients who had undergone a transthoracic vagus resection for treatment of a supposed duodenal ulcer on Dec. 19, 1946, with apparently good symptomatic relief on discharge, died eight months later at another hospital. A diagnosis of carcinoma of the stomach with metastasis was made at

6. Vanzant, cited by Walters, W.; Neibling, H. A.; Bradley, W. F.; Small, J. T., and Wilson, J. W.: Gastric Neurectomy: Anatomic and Physiologic Studies with Favorable and Unfavorable Results in the Treatment of Peptic Ulcer, Arch. Surg. **55**:151-163 (Aug.) 1947.

autopsy. It is obvious that this lesion must have existed at the time of his original operation, and this gives added strength to the contention that an abdominal approach, with direct visualization of the lesion, is preferable to the transthoracic approach (Walters and others,[7] Grimson and his associates[8]). Bradley and others[9] concluded that a subdiaphragmatic approach would allow nearly as complete a division of all the gastric nerves as a transthoracic approach in over 90 per cent of cases.

The remaining 9 patients all stated that they had had continued relief from pain. Pronounced symptoms referable to gastric atonia were present in 3 patients ten months postoperatively, consisting of postprandial belching, foul breath and postprandial fulness and/or distention. In spite of these symptoms, 1 patient had gained 18 pounds (8.2 Kg.) in weight and another 8 pounds (3.6 Kg.), and the weight of the third had remained stationary. Two of these 3 patients are dissatisfied with their result. Both of these patients had poor subjective results in the early postoperative period also. Urecholine® (carbominoyl-beta-methylcholine chloride) administered to each of these patients as described by Machella, Hodges and Lorber[10] was without clinical effect on gastric emptying. The remainder of the patients who showed roentgen evidence of gastric retention reported no troublesome symptoms of major importance relative to this finding, and all felt that they had been benefited by the operation.

Only 3 of the patients failed to report a gain in weight. One of these had a moderate diarrhea, which developed two months postoperatively and has persisted for seven months. No other cases of troublesome diarrhea were reported. A definite history of hemorrhage was obtained in only 1 patient, who stated that he had had several tarry stools since operation and was readmitted to the hospital with a severe hemorrhage eleven months after surgical intervention.

A summary of the subjective results is shown in table 7. It is noted that although 78 per cent of patients showed considerable roentgen evidence of gastric atonia ten months after vagotomy the symptoms of this complication were severe enough to be troublesome in only 33

7. Walters, W.; Neibling, H. A.; Bradley, W. F.; Small, J. T., and Wilson, J. W.: Gastric Neurectomy for Gastric and Duodenal Ulceration: An Anatomic and Clinical Study, Ann. Surg. **126**:1-18, 1947. Vanzant.[6]

8. Grimson, K. S.; Baylin, G. J.; Taylor, H. M.; Hesser, F. H., and Rundles, R. W.: Clinical Evaluation of Complications Observed After Transthoracic Vagotomy, Arch. Surg. **55**:175-179 (Aug.) 1947.

9. Bradley, W. F.; Small, J. T.; Wilson, J. W., and Walters, W.: Anatomic Considerations of Gastric Neurectomy, J. A. M. A. **133**:459-461 (Feb. 15) 1947.

10. Machella, T. E.; Hodges, H. H., and Lorber, S. H.: The Restoration of Gastric Motility by Urethane or B-Methyl Choline After Section of the Vagus Nerves for Peptic Ulcer, Gastroenterology **8**:36-51, 1947.

per cent. Our studies thus tend to corroborate the statement of Walters and others [6] that "the results are inconstant, variable and in most cases unpredictable."

B. Vagotomy Plus Complementary Gastric Operation.—Additional follow-up studies were also obtained on 11 patients who were subjected to gastroenterostomy or partial gastrectomy performed simultaneously with vagus resection.

All the patients from whom a history could be obtained reported notable subjective improvement without exception. Annoying subjective symptoms which might be attributable to gastric atonia were not present in any of the cases. There was no history of hematemesis or melena. Most of the patients were enthusiastic about their symptomatic

TABLE 7.—*Symptomatic Evaluation of Simple Vagotomy Three to Twelve Months After Operation*

Case	Relief of Pain	Symptoms of Gastric Atonia	Hemorrhage	Diarrhea	Change in Weight, Lb.	Evaluation by Patient	Months Since Operation
1	Complete	Severe	None	None	+18	Good	11
5	Complete	Mild belching and slight fulness	2 to 3 tarry stools; severe hemorrhage	None	+ 5	Good	11
7	Partial	Severe	Equivocal	Mild	+ 8	Poor	11
11	Partial	Severe	None	5 times daily	No change	Poor	10
14	Complete	None	None	None	+30	Excellent	9
12	Complete	None	None	None	+15	Excellent	10 Gastric ulcer
21	Complete	Mild	None	Severe	—15	Good	7
29	Complete	Mild	None	3 times daily	—10	Good	7
38	Complete	Mild	None	None	+ 1	Excellent	8

result. One patient in whom the right vagus had not been found at his original operation and who had continued to complain of pain in spite of an early postoperative reduction in gastric acidity underwent a lobectomy six months later for abscess of the lung, at which time the right vagus nerve was divided in the chest. This procedure was followed by relief of pain, and the patient was subsequently discharged symptom free. All the patients except 1 had gained weight.

Studies of gastric acidity were made on only 4 of these patients, 2 of whom had undergone gastroenterostomy and 2 with gastric resection. Both of the former showed no significant change in acid values in a three and six month interval, respectively. Interestingly, both patients in whom gastric resection had been done showed a complete absence of free acid in response to both histamine and insulin. Follow-up roentgenologic studies on 5 patients who had undergone gastroenterostomy revealed evidence of gastric atonia in 3. The retention was of consid-

erable degree, with 60 per cent in seven hours and incomplete emptying in twenty-four hours in 1 case seven months after operation, 75 per cent retention after six hours in another case six months postoperatively and 40 per cent retention three months postoperatively in the third case. Three patients studied who underwent vagotomy plus gastric resection showed no roentgenologic evidence of gastric retention. This indicates an incidence of 60 per cent gastric retention in spite of gastroenterostomy performed simultaneously with vagotomy as compared with an incidence of 78 per cent in patients treated by means of vagotomy alone (table 5). These figures coincide with the early postoperative figures and indicate that the disturbance of gastric motility is not as temporary as has been stated by some observers.

C. Vagotomy for Marginal Ulcer.—Of the 4 patients treated for marginal ulcer on whom we were able to obtain follow-up studies, all claimed an excellent symptomatic result. Of the 4 patients who were studied roentgenologically, 1 showed slight retention of barium after ten hours. In only 2 of these patients were studies of gastric acidity repeated. In 1 case there was a return to the preoperative level with the use of histamine and a rise of 25 degrees with the use of insulin five months after surgical intervention. In the second patient the histamine response exceeded the preoperative level, although the insulin response was unchanged.

COMMENT

Our findings thus far indicate a good subjective result in 85 per cent of the patients in this series, although 3 of 10 patients (30 per cent) who underwent vagotomy alone had severe symptoms related to gastric atonia as long as ten months postoperatively. The degree of subjective improvement is more striking and the incidence of complications reduced when complementary gastroenterostomy or gastric resection is done. Although there are too few cases to be conclusive, it seems that our best results were obtained in cases in which vagotomy was combined with gastric resection.

Roentgenologic studies revealed that over 75 per cent of patients who underwent vagotomy alone showed decided evidence of gastric retention. With complementary gastroenterostomy, gastric retention was present in over 50 per cent of cases, and with complementary gastric resection this complication was negligible. Roentgenologic studies repeated from three to twelve months postoperatively showed no reduction in the incidence of impaired gastric motility. The operation definitely produces a reduction in gastric acidity which is most noticeable (83 per cent) in the response to insulin-induced hypoglycemia, with a lesser reduction (50 per cent) in the night secretion and relatively little reduction (30 per cent) in the response to histamine.

Follow-up studies of gastric acidity as long as eleven months postoperatively indicated a slight rise in the response to insulin, with relatively little change in the night secretion or the histamine response. There has been no evidence of recurrent ulceration in this series thus far except in the case in which massive hemorrhage occurred ten months after vagotomy.

Since the follow-up period in this series of cases does not exceed twelve months, it seems that further studies are indicated at subsequent intervals before definite conclusions can be drawn as to the relative merit of vagotomy compared with present standardized surgical methods of treatment for peptic ulcer.

The results of vagotomy as thus far reported in the literature are not as consistently good as those reported for conventional gastric resection by Wangensteen,[11] Walters, Gray, Priestley and Counseller[12] and others. This study further substantiates these reports. It should be recalled, also, that the results thus far reported are no better than those reported during the years when gastroenterostomy alone was considered the surgical treatment of choice for peptic ulcer (Balfour[13]). It will be of interest to note the effect of vagotomy on the incidence of marginal ulcer over a long period in cases in which combined procedures have been done.

SUMMARY

1. Forty-two cases of peptic ulcer treated by resection of the vagus nerve are reviewed from the standpoint of early and late clinical results.

2. Two deaths are reported, one due to esophageal perforation at operation and the other due to gastric carcinoma unrecognized because of a transthoracic approach.

3. Early and late results are compared from the standpoint of subjective results and of effects on gastric acidity and on gastric motility.

4. The results of vagotomy in this series were best when this procedure was combined with gastric resection.

5. As a whole, the data in this series indicate that the results so far are not consistently as good after vagotomy as after conventional gastric resection.

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11. Wangensteen, O. H.: The Role of the Surgeon in the Management of Peptic Ulcer, New England J. Med. **236**:191-196, 1947.

12. Walters, W.; Gray, H. K.; Priestley, J. T., and Counseller, V. S.: Annual Report on Surgery of the Stomach and Duodenum for 1942, Proc. Staff Meet., Mayo Clin. **18**:505-511, 1943.

13. Balfour, D. C.: Results of Gastro-Enterostomy for Ulcer of the Duodenum and Stomach, Ann. Surg. **92**:558-562, 1930.

INTRAVENOUS ADMINISTRATION OF PROCAINE HYDROCHLORIDE FOR PAINFUL PROLAPSED HEMORRHOIDS

BURNETT SCHAFF, M.D.
AND
J. GORDON SPENDLOVE, M.D.
OTEEN, N. C.

PROLAPSED hemorrhoids are usually excruciatingly painful, yet unless strangulation ensues most surgeons prefer not to operate until the marked edema has subsided. During this period of waiting, which may last several weeks, the discomfort is often extreme. Although some relief may be afforded by putting the patient to bed, administering narcotics and applying heat or analgesic ointments locally, the severe pain frequently persists, and locomotion becomes difficult. To relieve the sufferings of these unhappy persons, a 1 : 1,000 solution of procaine hydrochloride was injected intravenously. This is a report of our experience with that method of treatment.

All the patients studied were men admitted for the treatment of severe pain in the anal region. Two types of pain appeared to be present—a sharp radiating pain and a dull pain localized in the anal region but increased by motion of the thighs. All the patients exhibited prolapsed hemorrhoids associated with edema and often ulceration of the anal mucosa; a few showed beginning strangulation. These patients had been treated, without relief, with the usually recommended procedures, some of which have been mentioned.

After a preliminary period of observation, some of the patients received a 1 : 1,000 solution of procaine hydrochloride intravenously in a volume containing 4 mg. per kilogram of body weight.[1] The predetermined dose was injected in exactly twenty minutes. Another group received 1 Gm. of procaine hydrochloride in a liter of isotonic

From the Department of Surgery, Veterans Administration Hospital, Swannanoa, N. C.

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1. Graubard, D. J., and Ritter, H. H.: Intravenous Procaine in the Treatment of Trauma, Am. J. Surg. **74**:765-769 (Nov.) 1947.

sodium chloride solution injected intravenously over a three to four hour period. The first method is suitable for the home and office and the second for the hospital. No barbiturates or narcotics were administered. To aid in reducing the anal edema, the patients were requested to stay in bed but were allowed bathroom privileges. During the period of this study only one intravenous injection of the procaine solution was given daily. The daily injections were continued until pain was markedly relieved. Usually no treatment was required after the third day.

The first injection was often accompanied with a sensation of warmth in the face or extremities; some patients occasionally complained of feeling faint. Succeeding treatments usually produced no significant reactions. In our experience with over four hundred injections no serious accidents have occurred.

The results of treatment are as follows: A definite reduction of the "sharp" pain occurred within three minutes after the first intravenous injection was started. The dull localized pain subsided shortly thereafter. Complete comfort persisted for five to ten hours after the twenty minute method and for seven to twelve hours after the longer procedure. Partial relief for the remainder of the day followed with both methods. Some rectal discomfort was present the next morning, but on repetition of the treatment it abated in a similar manner. If pain then recurred, it did so with diminished fury. The procaine hydrochloride was usually needed through the third day; thereafter, many patients were comfortable and required no further medication. It was noted that ulceration, if present, frequently healed by the fifth day. The treatment may have diminished the duration of the edema, but this was difficult to evaluate without a large series of controls. Some hemorrhoids still protruded several days after cessation of treatment, but, peculiarly enough, they no longer gave rise to severe symptoms.

The results of treatment have been almost identical in all our cases. Three representative histories are given to demonstrate the effect of intravenous administration of procaine hydrochloride.

CASE 1.—A 48 year old Negro was admitted to the hospital with a history of having his "whole rectum" protrude suddenly six days previously. He complained of severe anal pain and weakness. On examination, internal hemorrhoids were found prolapsing through a tight sphincter; there was marked edema, and an area of necrosis in the rectal mucosa measured 1.5 cm. in diameter.

At noon on Jan. 29, 1948, a grain (60 mg.) of codeine was given subcutaneously, without relief; the prolapsed hemorrhoids were extremely painful. At 1:45 p. m., injection of a 1:1,000 solution of procaine hydrochloride was started, and the pain was relieved four minutes later. At 2:05 p. m. 300 cc. of the solution had been given and the intravenous injection was discontinued. The patient was able

to walk about without pain for the first time since the onset of his illness. Pain returned at 5:30 p. m. but disappeared sponstaneously at 8 p. m.

On January 30 the patient felt better but still had anal pain and edema. A 1:1,000 solution of procaine hydrochloride in isotonic sodium chloride solution was injected intravenously. This was discontinued after 300 cc. had been given in exactly twenty minutes. The anal discomfort was completely relieved.

On January 31 the ulceration of the rectal mucosa appeared to be unchanged. The edema of the prolapsed structures had diminished about 50 per cent, and little rectal pain was present. Although the edema appeared to be slight, pain had recurred in the anal region by February 4. The patient was given 300 cc. of procaine hydrochloride as before in exactly twenty minutes, beginning at 8:25 a. m. At 2:15 p. m. he had a bowel movement without pain, but he noticed a burning sensation during defecation.

On February 5 the ulceration of the rectal mucosa appeared to be healed. No pain was present. The patient was discharged on February 9 with his ulcer healed, the edema gone and the prolapse of his internal hemorrhoids no longer present.

CASE 2.—A 38 year old white man was admitted with a history of having had hemorrhoids since February 1945. On various occasions they had "dropped out," remaining out for several days and causing severe pain and bleeding. Four days prior to his admission the hemorrhoids had again "dropped out," and the patient was unable to reduce them. The pain was so severe that he was admitted for emergency treatment.

On examination, large prolapsed internal hemorrhoids were found. One of them appeared to be thrombosed. Although considerable edema was present, there was no ulceration of the prolapsed mucosa.

On March 24, 1948, beginning at 8:25 p. m., the patient was given 1 Gm. of procaine hydrochloride dissolved in 1 liter of isotonic sodium chloride solution. The solution was given over a three hour period. During the injection the patient fell asleep and slept well all night. At noon on March 25 the same injection was repeated. The patient had no reaction and felt comfortable. At 7 p. m. he was up and about the ward. On March 26 the extent of the prolapse appeared to be diminished. At 10 a. m. a liter of 1:1,000 solution of procaine hydrochloride was given. The patient had no pain during the remainder of the day but did complain of some soreness during defecation.

On March 27 the injection was repeated. The edema was decreasing, and little pain was present. The pain disappeared completely after the beginning of injection of procaine. The patient still had some soreness during defecation, however. On March 31 the prolapse was completely reduced. Rectal examination revealed a tight sphincter, but the examining finger could be passed through it.

On April 1 a hemorrhoidectomy was performed. Moderate edema of the external hemorrhoids was noted during the operation.

CASE 3.—A 50 year old Negro was admitted for the treatment of severe anal pain. Hemorrhoids had been present for the past ten years, but five days prior to his admission they had prolapsed.

On examination, prolapsed internal hemorrhoids were found associated with ulceration of the prolapsed mucosa. The ulcer measured 1 cm. in diameter. A severe grade of edema of the prolapsed structures was also noted.

On March 11, 1948, the patient complained of severe anal pain. At 9:15 a. m. injection of a 1:1,000 solution of procaine hydrochloride in isotonic sodium chloride

solution was started. At 9:18 a. m. the "shooting" pain was gone; soreness on motion was present in the anal area. At 9:20 a. m. there was less soreness on motion, and no toxic symptoms were noted. At 9:25 a. m. the patient began to feel "funny." This seemed to be caused by a sensation of warmth all over the body. At 9:28 a. m. the "funny" sensation had disappeared. At 9:35 a. m. the intravenous injection was discontinued after 300 cc. had been given. No pain was present at this time.

On March 12 there was some pain in the anal region, but this appeared to be milder than on the previous day. Three hundred cubic centimeters of a 1:1,000 solution of procaine hydrochloride in dextrose was injected intravenously; no reaction occurred. On March 13 the edema of the prolapsed structures had diminished about 25 per cent, and the ulceration had decreased in size. There was much less pain, but soreness on motion persisted. The procaine solution was again injected intravenously.

On March 15 there was no pain. Some prolapsed hemorrhoids were present on the left; those on the right appeared to have reduced. On March 17 the ulceration of the prolapsed rectal mucosa had healed. The patient felt comfortable.

On March 18 the patient was up all morning. At noon the hemorrhoids again prolapsed; attempts at reduction failed. He was treated with narcotics and Sitz baths, without relief. The injection of procaine solution was repeated at 3:15 p. m., with complete relief of pain. Three hundred cubic centimeters was given in exactly twenty minutes. No pain was present on March 19. By March 29 pain was still absent. The hemorrhoids were ready for operation since March 20, but the patient was watched for the purpose of this study. There appeared to be some rectal mucosa everting through the relaxed anal sphincter. On April 1 a modified Whitehead type of operation was done.

COMMENT

There are various factors accounting for the success of this method of treatment. The nerve supply of the veins is similar to that of the arteries since both show nerves ending in the adventitia and the media. Some claim to have demonstrated nerve endings in the intima. One would therefore expect to find relief of pain in a disease of the veins, such as prolapsed hemorrhoids, by a direct action of the anesthetic solution on the nerve endings.[2] In addition, there is evidence suggesting that procaine hydrochloride diffuses easily through the vessels showing increased permeability because of disease. It has been demonstrated that after trauma the concentration of procaine hydrochloride in the traumatized area is seven to eight times that in the blood.[1] When the hemorrhoids are prolapsed or strangulated, there is notable edema of the structures, and it is likely that the solution diffuses into the edematous areas and there exerts its well known anesthetic effect, which relieves the dull localized type of pain and the pain increased by motion of the thighs. It is probable that the

2. De Sousa Pereira, A.: The Innervation of the Veins, Surgery **19**:731-742 (May) 1946.

condition of prolapse or strangulation of the hemorrhoids sets up a reflex vasospasm and sphincter spasm which causes the sharp shooting pains. This reflex vasospasm has been demonstrated in thrombophlebitis of the lower extremities. The procaine hydrochloride acting on the nerves in the prolapsed hemorrhoids blocks the starting point of the reflex, thus relieving the reflex vasospasm and the sphincter spasm. Relief of sphincter spasm is suggested by the fact that several days after treatment is discontinued protruding hemorrhoids, although still present, are relatively painless. Relief of the reflex vasospasm may account for the rapid healing of the ulcers in the protruded mucosa.

SUMMARY

A solution of procaine hydrochloride injected intravenously in recommended doses gave prompt and considerable relief of pain in 3 patients with prolapsed hemorrhoids.

TREATMENT OF CANCER OF BREAST BY SIMPLE MASTECTOMY AND ROENTGENOTHERAPY

ROBERT McWHIRTER, F.R.C.S., F.F.R.
EDINBURGH, SCOTLAND

CANCER of the breast is one of the commonest forms of malignant disease in women. If it is fully treated when still localized, many lives may be saved. The maximum number of lives will be saved by the use of the most effective methods of treatment. So that these may be recognized it is essential that a reliable means of assessment be employed.

The very fact that there is still great doubt regarding which method is best suggests that the usual methods of assessment are not reliable. To continue to publish unreliable assessments will only further confuse the issue; much time and energy will be wasted, and many lives may be lost.

Some of the present confusion undoubtedly arises from the failure to appreciate that the value of a method of treatment depends not on the results obtained in the treated patients but on the number of lives a method may save. Thus if a method is suitable for only a limited number of cases it cannot be regarded as a good method even though the results obtained in the few selected cases may be good.

There is no more certain method of securing good results than by careful selection of patients for treatment, but by restricting a method to only the most favorable cases some lives may be lost that might otherwise be saved. It must rarely happen, however, that lives will actually be sacrificed so that good results will be obtained, but it is not uncommon to limit the use of a method to early cases and to apply some alternative method in the more advanced cases. Thus as the limitations of radical mastectomy become more clearly recognized, it has become customary to restrict the operation to early cases and to refer all the more advanced cases for treatment by roentgenotherapy. If only treated patients are considered, the results from radical mastectomy in these circumstances will appear to be good.

There is little doubt that the improved results now being recorded for radical mastectomy are due to more careful selection, but the care taken in the selection of patients varies greatly from surgeon to surgeon, and the variation in the results presented is almost certainly due more to this variation in selection than to any difference in operative skill.

It is of course desirable that some selection should take place, for to operate in advanced cases may not only shorten life but may in addition increase the terminal discomfort of the patient.

From what has been said it will be obvious that when two methods of treatment are being compared an entirely erroneous conclusion may be reached if the comparison is based entirely on the patients actually treated. It cannot be too strongly emphasized that the true value of a method of treatment depends just as much on the number of cases to which it will apply as on the results obtained when it is applied. In order to avoid the distorting influence of selection the fact must be accepted that the only really reliable survival rates are those obtained by expressing the number of survivors as a percentage of the total cases referred. No case must be omitted from the total for any reason whatsoever.

It is agreed that the proportion of advanced cases may vary from one hospital to another, but it is difficult to see how proper allowance can be made for this. A common method of attempting to overcome this difficulty is to make use of one of the many systems of staging. None of the methods of staging so far devised is free from variation in interpretation. The following example will show the dangers of comparing the value of two methods of treatment on this basis.

Two Identical Series of Patients Treated by Methods of Equal Value

	Stage I	Stage II
Series A	Early cases	Advanced cases

	Stage I	Stage II
Series B	Early cases	Advanced cases

Owing to a difference in interpretation, the cases in stage I of series A have been more carefully selected than the cases in stage I of series B. In consequence, in stage I series A there will be fewer moderately advanced cases than in stage I series B. The results in stage I series A will therefore be higher. In stage II series A the results will also be higher because there will be more cases in which the disease is only moderately advanced than in stage II series B. Comparison by stages might suggest that the method used in series A

was better than that used in series B. It should be noted that the survival rates will be the same when the total number of survivors is expressed as a percentage of the total number of patients.

The same findings will be obtained when the subdivision extends to more than two groups. For the same reasons it is equally dangerous to compare the value of two methods of treatment by a division of cases into operable and inoperable groups.

A fuller account of the influence of selection has been given elsewhere,[1] but the following brief summary will provide some indication of the essential points which must be observed when methods of treatment are being compared.

1. When the value of any method or combination of methods is being assessed no case must be deducted from the total. Cases in which treatment was not completed and cases in which the method cannot be applied are just as much failures as those in which full treatment was given and the patient failed to be cured.

2. The only reliable results are those of a large general hospital where records are made of all patients coming to the hospital irrespective of whether they are admitted or not.

3. The limitations of any method of staging—clinical, histologic or a combination of the two—must be recognized, and while results may be presented by stages the figure of greatest value is the survival rate for all the stages taken together. This figure should always be stated.

4. When the proportion of untraced patients is high, it is best to express the survival rate as lying between two percentages. These two percentages are obtained by assuming, on the one hand, that all untraced patients are alive and, on the other, that they are all dead.

5. While deaths from intercurrent disease may be deducted, the death rate from these causes should not exceed that for the corresponding age group of the population as a whole.

6. "Clinical cure rates" and "symptoms free rates" are too unreliable to be of value. Even when the assessment is made at the clinic there may be considerable doubt as to whether the patient is free from disease or not, and when the assessment is made by the patient or by the family physician, it is, as a rule, so unreliable as to be of limited value. The "clinical cure rate" must always remain a statement of opinion and, therefore, less reliable than the survival rate, which is a statement of fact.

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1. McWhirter, R.: The Value of Simple Mastectomy and Radiotherapy in the Treatment of Cancer of the Breast, Brit. J. Radiol. **21**:252 (Dec.) 1948.

The adoption of this basis of assessment will provide results which may come as a great disappointment to those who in the past have been content to calculate the survival rates of only those patients who were fully treated.

Thus while five year survival rates varying (according to the degree of selection) from 35 to 45 per cent may be obtained for patients actually treated by radical mastectomy, I do not believe that the five year survival rate will exceed 25 per cent when all cases referred to a large general hospital are included in the total on which the survival rate is based.

Put in another way, the radical operation fails in approximately 75 per cent of cases as judged by the five year survival rate. It was because radical mastectomy was recognized to fail in so many cases that it was decided in Edinburgh to explore the value of other methods of treatment.

The value of combining postoperative roentgenotherapy with radical mastectomy was first investigated. The method was successful in reducing the number of local recurrences, but many patients continued to die from distant metastasis. This led to the belief that dissection of the axilla might cause dissemination of malignant cells to sites beyond the area which could be irradiated. At the time of the operation tissues invaded by the tumor must commonly be divided and the trauma inflicted on involved tissues must increase the natural tendency of malignant cells to be disseminated to distant sites. Should cells be disseminated to distant sites before roentgenotherapy is applied, the latter will not be effective in saving the life of the patient. In an attempt to overcome this difficulty it was decided to continue to remove the breast surgically but that the treatment of the axilla should be by roentgenotherapy alone.

FACTORS WHICH SUGGESTED THE USE OF SIMPLE MASTECTOMY AND ROENTGENOTHERAPY

The decision to treat cancer of the breast by this means was taken at a meeting of the surgical staff in 1941. The decision was made for the following reasons.

1. When the disease is confined to the breast, surgical intervention gives good results. Surgical treatment is thus an effective method of treating the disease in the breast, and it was decided that surgical removal should be continued.

2. While at first sight surgical intervention might appear to be the most satisfactory method of treating the axilla, a more careful examination will show that its value is in fact limited. It is true that the results are excellent when the axillary glands are not involved, but if there are

no malignant cells in the axilla it would appear unnecessary to dissect it, for the removal of normal lymph nodes cannot influence the result. On the other hand, when the axilla is secondarily involved, there is universal agreement that radical mastectomy often fails to save the life of the patient. Since, therefore, surgical removal of the glands is unnecessary when the axilla is not involved and often fails when the axilla is involved, it was decided to treat the axilla by roentgenotherapy to see if better results could be obtained.

3. In many forms of cancer roentgenotherapy has now become the treatment of choice, and in carcinoma of the breast it has been shown that postoperative recurrences can be effectively treated by this means. Immediate postoperative roentgenotherapy will greatly reduce the number of local recurrences. From these observations it must be concluded that this therapy can destroy breast cancer cells and that it is at least an alternative method of treating the axilla.

Soon after this method of treatment was introduced it was found that a much higher proportion of patients could be given full treatment than had been possible before. Thus the prospect of cure was offered to a greater number of patients, and, as will be shown later, patients with fixed axillary glands and with glands present in the supraclavicular region were treated with a considerable measure of success.

The wound heals more quickly after the simple mastectomy. Roentgenotherapy can therefore be applied with less delay, and the interval during which cells may escape to distant sites is thus reduced.

When patients are treated by radical mastectomy and roentgenotherapy, edema of the arm is common. With simple mastectomy and roentgenotherapy edema of the arm is almost unknown.

DATA FOR YEARS 1941 TO 1945

Number of Cases.—In the period 1941 to 1945 the number of cases of cancer of the breast referred to the Royal Infirmary was 1,451, and of this number 1,334 were primary cases. The remaining 117 patients had all been treated elsewhere and were referred only after the development of recurrences.

Each primary case was classified when it was first seen, and the classification adopted was that suggested by Paterson of Manchester.[2] It should be noted that this classification is based entirely on the preoperative clinical findings.

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2. The Results of Radium and X-Ray Therapy in Malignant Disease: Second Statistical Report from the Holt Radium Institute, Manchester, 1934-1938.

Operability.—There are many standards of operability, and, as already indicated, all of them are subject to great variation in interpretation. It is, nevertheless, convenient in the presentation of an account of the results to divide cases into groups.

In a previous communication [3] the condition in stages I, II and III of the classification in table 1 was regarded as operable, but it would appear that this standard is too low. It is now recognized that stage III cases are too advanced for treatment by radical mastectomy, and, in order to conform to modern standards, only stages I and II will now be included in the operable category. The definition of operability will then read as follows:

The primary tumor, which may be of any size, may show any degree of cutaneous involvement up to and including ulceration, but there must be no isolated nodules of the skin or other manifestation

TABLE 1.—*All Primary Cases Referred in the Period 1941 to 1945*

	Stage I	Stage II	Stage III	Stage IV	Total
Number	405	344	182	403	1,334
Percentage	30	26	14	30	100

TABLE 2.—*Results in Advanced Cases with Respect to Metastases*

1941 to 1945	Operable Cases	Advanced, Without Distant Metastases	Advanced, with Distant Metastases	Total
Number	749	387	198	1,334
Percentage	56	29	15	100

of invasion of the cutaneous lymphatic vessels. The extent of involvement of the skin must not be so great as to necessitate skin grafting when radical mastectomy is performed, and the tumor must not be fixed to the pectoral muscle. The axillary glands of the same side may be enlarged, but they must not be fixed. The supraclavicular glands must not be enlarged, and there must be no clinical or roentgenologic evidence of more distant metastases.

It will be observed that stage I and stage II cases constitute 56 per cent of the total cases referred. During the period when radical mastectomy was employed it was found that in 60 per cent of the cases in stage I and in 15 per cent of the cases in stage II the axillary glands were not involved on histologic examination. When the two stages are taken together to form the operable group, it may therefore be

3. McWhirter, R.: The Treatment of Cancer of the Breast, Proc. Roy. Soc. Med. **41**:122 (Feb.) 1948.

presumed that in 40 per cent of cases the axillary glands will not be histologically involved, while in the remaining 60 per cent the glands will be found to be invaded by malignant cells.

For further convenience in the presentation of the results the advanced cases have been divided into two groups in table 2 according to whether or not distant metastases were present.

Operative Mortality.—The operations were performed by upward of forty different surgeons, and, while only 11 postoperative deaths (death within a month from any cause was regarded as a postoperative death) are known to have taken place, it was decided to add another 11 deaths to the total to allow for any possible further postoperative deaths in patients who were operated on outside the Royal Infirmary. These added deaths are almost certainly in excess of the number which actually took place, but as the exact number was unknown it was decided to err on the safe side so as to avoid any criticism that might arise.

Of the 11 known deaths, there were only 4 in patients under 65 years of age. The remaining 7 occurred in elderly debilitated patients.

Untraced Patients.—No patient was untraced.

Histologic Confirmation.—Of the operable cases, 97 per cent were histologically proved, and among the total there was histologic confirmation in 87 per cent. The cases not histologically proved were mainly those too advanced for any surgical treatment.

Calculation of Survival Rate.—The method adopted is that advised by Dr. Lewis-Faning of the Medical Research Council. A full account of the method cannot be given here, but briefly it may be stated that, while the five year survival rate of the patients treated in the period 1941 to 1945 is mainly determined by the patients treated in 1941 and 1942, the rate is influenced by the patients treated in the later years. By allowing the more recently treated patients to influence the five year survival rate, a figure is obtained which is more reliable than that based on the 1941 and 1942 cases alone.

For comparison the five year survival rate calculated by the more usual method is given at the end of table 5. It so happens that there is no great difference between this figure and that obtained by the method adopted. The method advised by Dr. Lewis-Faning, however, has the great advantage that the five year survival rate is based on a much larger number of cases and is therefore to be preferred.

SURVIVAL RATE FOR ALL OPERABLE CASES IN THE PERIOD 1941 TO 1945

As has been stated the main method of treatment in this period was simple mastectomy and roentgenotherapy. Full treatment was possible in almost all cases, but whether this was given or not, every case classified as operable has been included in table 3.

As will be observed from the last column the five year survival rate is 62.1 per cent.

During the period 1935 to 1940, the main method of treatment was radical operation and postoperative roentgenotherapy, and of the 411 patients whose condition was operable, 50.1 per cent were alive at the end of five years.

Statistical examination shows that this difference in the survival rates is significant, and the findings, so far as the five year survival rate is concerned, suggest that roentgenotherapy is a better method of treatment of the axilla. The findings obtained in the advanced cases without distant metastases support this observation.

TABLE 3.—*Survival Rate for All Operable Cases in the Period 1941 to 1945 (Total Cases, 757)*

Years After Treatment	Number of Deaths from Cancer	Number Exposed to Risk	Chance of Dying in Any One Year	Survival Rate, Percentage
1	49	757	0.065	93.5
2	69	704.5	0.098	84.4
3	58	477	0.122	74.1
4	34	317	0.107	66.2
5	10	161.5	0.062	62.1

TABLE 4.—*Survival Rate for All Advanced Cases Without Distant Metastases in the Period 1941 to 1945 (Total Cases, 389)*

Years After Treatment	Number of Deaths from Cancer	Number Exposed to Risk	Chance of Dying in Any One Year	Survival Rate, Percentage
1	89	389	0.229	77.1
2	79	299.5	0.264	56.8
3	47	181.5	0.259	42.1
4	17	93	0.183	34.4
5	8	51.5	0.155	29.0

SURVIVAL RATE FOR ALL ADVANCED CASES WITHOUT DISTANT METASTASES IN THE PERIOD 1941 TO 1945

Treatment by simple mastectomy and roentgenotherapy was possible in only a limited number of cases, but, as in table 3, all patients whether fully treated or not, and all untreated patients are included.

The cases in this group are essentially those in which the disease was too advanced to be treated by radical mastectomy but was still to some extent localized, so far as could be ascertained by clinical and roentgenographic examination. The group therefore includes all cases in which the primary tumor was fixed to the pectoral muscle or to the underlying ribs and all cases in which there were fixed axillary glands or glands present in the supraclavicular region.

It will be seen from table 4 that 29 per cent of the patients were alive at the end of five years. This remarkably high figure clearly demonstrates that roentgenotherapy is an effective method of treatment of the axilla even when the axillary involvement is gross.

SURVIVAL RATE FOR ALL CASES IN THE PERIOD 1941 TO 1945

The analysis would not be complete without consideration of the results obtained in all the cases taken together.

It will be observed from table 5 that the five year survival rate for all cases referred during the period 1941 to 1945 was 43.7 per cent. It is interesting once again to compare this figure with that obtained during the period 1935 to 1940, when the main method of treatment

TABLE 5.—*Survival Rate for All Cases Referred in the Period 1941 to 1945 (Total Cases, 1,345)*

Years After Treatment	Number of Deaths from Cancer	Number Exposed to Risk	Chance of Dying in Any One Year	Survival Rate, Percentage
1	260	1,345	0.193	80.7
2	197	1,061	0.182	66.0
3	113	684.5	0.165	55.1
4	55	423	0.130	47.9
5	19	218	0.087	43.7

Calculation of the survival rate by the more usual methods gives almost the same result:

Total number of patients referred during 1941 and 1942 less patients who died from intercurrent disease	459
Number alive at the end of five years	197
Five year survival rate	42.9%

was radical mastectomy and postoperative roentgenotherapy. There were 790 cases referred during this earlier period, and the five year survival rate was 32.4 per cent.

THE EXTENT OF SELECTION OF CASES IN THE PERIOD 1941 TO 1945

All patients referred to the Royal Infirmary during this period have been presented. Reference to table 2 shows that 198, or 15 per cent, of the total number had clinical or roentgenographic evidence of distant metastases.

It will be recalled, too, that 11 deaths were added to the total to allow for any possible further postoperative deaths in patients operated on outside the Infirmary.

From 1941 to 1945 the annual number of patients referred was higher than at any other time. Part of this increase is explained by the fact that since 1941 an attempt has been made to ascertain the incidence of cancer of the breast in southeast Scotland, and, in order to do so, the general practitioners in the area were specially requested

to refer all cases to the Royal Infirmary, no matter how advanced they were. The evidence presented in figure 1 suggests that most cases are now being referred.

The significant feature in figure 1 is the fact that nearly all deaths now being recorded by the Registrar-General are occurring in patients already referred to the Royal Infirmary. All or nearly all patients must be referred for several years before such a high percentage is obtained. It may therefore be assumed that nearly all cases of cancer of the breast occurring in southeast Scotland are now being referred to the Royal Infirmary. From these observations it can be claimed with considerable

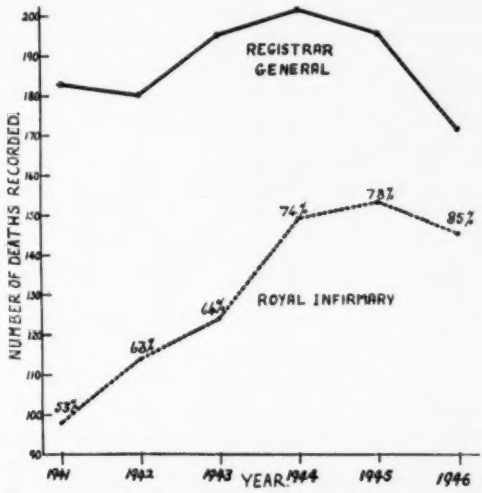

Fig. 1.—The number of deaths from cancer of the breast occurring in patients referred to the Royal Infirmary from the southeast of Scotland has been expressed as a percentage of the deaths recorded by the registrar-general from the same area.

confidence that the results obtained during the period 1941 to 1945 are based on unselected cases. In all probability the results are less influenced by selection than any figures hitherto published.

It is almost superfluous to add that if the reference of all advanced cases had not been specially requested, still higher survival rates could have been presented.

CARCINOMA OF THE BREAST WITHOUT DISTANT METASTASES

Table 6 is presented for interest. It shows the results obtained in all cases without clinical or roentgenologic evidence of distant metastases and is obtained by adding together cases in tables 3 and 4.

The table shows that when there was no evidence of distant metastases 1 of every 2 patients was alive at the end of five years.

TECHNIC OF SIMPLE MASTECTOMY AND ROENTGENOTHERAPY

A full account cannot be given of all the technical details of treatment by simple mastectomy and roentgenotherapy, but the following is a brief summary of the essential points.

The method of treatment is a combination of two procedures which must be coordinated if the best result is to be obtained.

The following points are of importance in the surgical aspect of treatment:

1. Preoperative preparation with iodine is contraindicated because it lowers the tolerance of the skin to roentgenotherapy.

2. The incision in the skin and the undermining of the skin flaps should be as limited as possible so that tissue spaces outside the area to be irradiated will not be contaminated with malignant cells liberated during the operation.

TABLE 6.—*Survival Rate of All Patients Without Clinical or Roentgenologic Evidence of Distant Metastases in the Period 1941 to 1945 (Total Cases, 1,146)*

Years After Treatment	Number of Deaths from Cancer	Number Exposed to Risk	Chance of Dying in Any One Year	Survival Rate, Percentage
1	138	1,146	0.120	88.0
2	148	1,004	0.147	75.0
3	105	658.5	0.160	63.0
4	51	410	0.124	55.2
5	18	213	0.085	50.5

3. Excessive skin should not be removed, for tension on the skin flaps may be associated with failure of the wound to heal and delay in the application of roentgenotherapy. Tightly stretched skin flaps do not tolerate irradiation well. Skin grafting does not overcome the difficulty, for grafts do not tolerate roentgen rays well.

4. When the primary tumor is mobile on the pectoral fascia, the fascia should not be removed, as this promotes fibrosis of the pectoral muscle. If the tumor is firmly fixed to the pectoralis major, the muscle should be removed together with the breast.

5. If there are no palpable axillary glands, dissection should not be performed, but superficial mobile glands in the subpectoral region and outside the axillary fascia may be removed. Any further dissection of the axilla will defeat the whole purpose of the method of treatment advocated.

6. If the patient is stout, it is better to carry out a radical mastectomy because in such patients it is difficult to deliver an adequate dose of roentgen rays to the axilla.

7. Supraclavicular glands should never be removed because these glands are easily and effectively dealt with by roentgenotherapy.

8. Adhesive should not be applied to the skin after the operation because this lowers the tolerance of the skin to irradiation.

The following points are of importance in postoperative treatment by roentgenotherapy:

1. Only one full course of roentgen ray treatment should be given. The practice of repeated courses at intervals of three to six months has no place in the treatment of any form of malignant disease when cure is to be attempted and is just as illogical as partial removal of a tumor at intervals of three to six months.

2. Roentgen ray treatment should be commenced as soon as possible after the operation; the usual interval is two weeks.

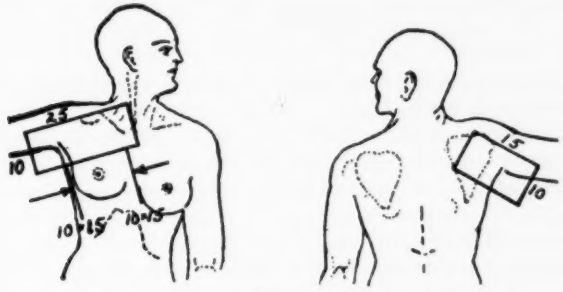

Fig. 2.—Arrangement of the fields in roentgenotherapy.

3. Four fields are used, and each field is treated every day. Irradiation of the axilla is carried out in two opposed fields, and the anterior field extends up to include the supraclavicular region. The thoracic wall must be treated by tangential or glancing fields so as to avoid pulmonary fibrosis. The arrangement of the fields is shown in figure 2.

4. An adequate dosage must be given, and in Edinburgh the patients receive a minimal tumor dose of 3,750 r in a period of three weeks. This is the same dosage as is given when clinically obvious local recurrences are treated, and it is important not to give less.

5. The x-ray apparatus must be sufficiently powerful to deliver an adequate depth dose in the axilla, and it is doubtful if effective roentgenotherapy can be given with an apparatus of lower voltage than 250 kilovolts. Heavy infiltration is employed, and the half-value layer of the beam is 3.7 mm. of copper.

SUMMARY

An account has been presented of the method of treatment of cancer of the breast at present in use in Edinburgh. It must be accepted as representing but one direction in which the survival rates may be improved. There may be other better methods.

Considerable emphasis has been placed on the importance of assessing the true value of a method of treatment so that better methods may be recognized without undue delay. The view has been expressed that the publication of results of selected cases has greatly confused the issue and has tended to convey the impression that radical mastectomy is a highly successful method of treatment of cancer of the breast.

When radical mastectomy is the only method of treatment available and when all cases coming to a large general hospital are taken into account, the five year survival rate is unlikely to exceed 25 per cent.

A brief account of the method of treatment by simple mastectomy and roentgenotherapy has been presented. The five year survival rate for all cases coming to the Royal Infirmary in the period 1941 to 1945 is 43.7 per cent.

The most important feature of this method is the substitution of roentgenotherapy for surgical intervention in the treatment of the axilla. The decision to do so was taken because when the axilla is not involved by malignant cells it appears unnecessary to carry out an axillary dissection and when the axilla is involved the results of surgical dissection are poor.

The fact that a five year survival rate of 29 per cent was obtained in the advanced cases without distant metastases indicates that roentgenotherapy, even in such adverse circumstances, is an effective method of treating the axilla. It is therefore not surprising that this same method of treatment in operable cases should be associated with a survival rate much higher than that obtained by radical mastectomy.

A high standard of roentgenotherapy is essential, and adequate dosage must be given. It is most important to appreciate that simple mastectomy and a low standard of roentgenotherapy will be associated with results poorer than those obtained by radical mastectomy without any roentgenotherapy.

Figure 1 has been reproduced by kind permission of the editors of the *Proceedings of the Royal Society of Medicine.*

ANESTHESIA IN TRAUMATIC CONDITIONS

FRANCIS F. FOLDES, M.D.
PITTSBURGH

GENERAL CONSIDERATIONS

THE PURPOSE of this paper is to present an outline of the procedures used to induce anesthesia in traumatic surgery. Underlying principles and general considerations will be emphasized at the expense of detailed discussion of various technics.

1. Preparation of Patient.—Correction of shock is an essential preliminary of anesthesia and operation in traumatic conditions. If immediate intervention is not a question of life or death, attention should be directed to certain problems before the induction of anesthesia.

If the patient is conscious, or other persons able to give pertinent information are present, a careful history should be taken. This should be followed by as thorough a physical examination as is permitted by the patient's injury, supplemented by the necessary and feasible laboratory examinations.

Such an examination often reveals conditions that need attention more urgently than the injury which was at first considered to be of primary importance. It has occurred that while an operating team was busy correcting a compound fracture of a limb the patient died of internal hemorrhage because of a ruptured spleen or kidney. The examination might also reveal preexistent pathologic conditions (such as heart disease or diabetes) which can be corrected to some extent and which might influence the surgeon regarding the type and the extent of the contemplated procedure.

Certain mechanical problems also need attention before the start of the anesthesia. If the injury followed a heavy meal, the stomach should be emptied whenever possible. It is also important to have the patient in a comfortable position that interferes the least with free respiration before the induction of anesthesia.

The treatment of shock includes the administration of analgesic and sedative drugs. If general anesthesia is to be employed, these drugs should be supplemented by parasympathetic depressants, atropine or scopolamine. These agents diminish the secretions of the upper respiratory and gastrointestinal tracts and diminish vagus irritability. Addi-

From the Department of Anesthesiology, Mercy Hospital.

tional doses of sedative and analgesic drugs should also be administered, if necessary. Great caution should be exercised in the administration of these drugs. It should be kept in mind that patients in shock, or just out of shock, with perhaps a suboptimal blood volume, are extremely sensitive to depressants and need considerably smaller doses than would correspond to their age and weight. Furthermore, the time interval between the administration and the action of depressants is often delayed in these patients, and often a second dose has been administered before the first dose had time to exert its full effect. This and the fact that the decomposition and elimination of drugs can also be delayed in injured patients might cause severe overdosage. Such overdosage can become even more serious if general anesthesia is superimposed on it. Morphine is especially dangerous in this respect, and extra care should be exercised in its administration to injured patients.[1] It should be administered only before anesthesia if the patient is actually in pain despite the fact that the previous analgesic dose had ample time to exert its effect or if the procedure is painful and the anesthetic agent to be used is not potent (nitrous oxide and oxygen) or has a relatively weak analgesic effect (thiopental sodium, U. S. P.). If only sedation is desired, one of the short-acting barbiturates (e. g., pentobarbital sodium) and/or scopolamine gives more sedation, with less accompanying respiratory depression, than morphine.

2. Anesthetic Agents.—The agents used to produce surgical anesthesia might be divided into two groups. The first group is composed of agents that impede conduction of the peripheral nerves. This group can be subdivided into the so-called local anesthetic agents and cold. Perhaps the most often used local anesthetic agents are procaine hydrochloride, piperocaine hydrochloride (metycaine hydrochloride®), tetracaine hydrochloride (pontocaine hydrochloride®) and dibucaine hydrochloride (nupercaine hydrochloride®). Their potency, toxicity and duration of action follow the order in which they are given here. The rapid intravascular injection of the local anesthetic agents might have serious consequences. The possibility of allergy to these agents also has to be kept in mind, especially in regard to patients with a history of allergy (hay fever, asthma and other conditions). A 1:1,000 solution of epinephrine and a 2.5 per cent solution of thiopental sodium (pentothal sodium®) should always be at hand when local anesthetic agents are used. The intravenous administration of 0.1 to 0.2 cc. of epinephrine can be of life-saving importance in the presence of allergic manifestations, and thiopental sodium is the antidote of choice against convulsions caused by the intravascular administration of local anesthetic agents.

1. Beecher, H. K.: Delayed Morphine Poisoning in Battle Casualties, J. A. M. A. **124**:1193-1194 (April 22) 1944.

Cold has been used in the form of prolonged ice packs to produce conduction anesthesia.

The general anesthetic drugs are divided into inhalation, intravenous and rectal agents. The inhalation agents can be subdivided into gases and vapors. The most often used gases are nitrous oxide, ethylene and cyclopropane in this order of potency. Nitrous oxide or ethylene mixed with at least 20 per cent of oxygen produces moderate to good analgesia and amnesia, ethylene more so than nitrous oxide. Cyclopropane produces much deeper anesthesia than these two agents, with complete analgesia but sometimes inadequate relaxation. Ethylene and cyclopropane are explosive in anesthetic concentrations and have been the cause of many fatal explosions. Cyclopropane sometimes causes sudden serious cardiac disturbances.

Ether, vinyl ether (vinethene®) and chloroform are fluids with low boiling points, and their vapors are used to produce anesthesia. Their potency and toxicity increase in the order given. They are capable of producing deep anesthesia with relaxation, but the relaxation produced by vinyl ether is not always complete. Ether and vinyl ether are also explosive but less so than ethylene and cyclopropane.

Thiopental sodium is the almost exclusively used intravenous anesthetic agent. It produces good amnesia but only fair analgesia and poor relaxation. The reflex irritability of the vagus nerve seems to be increased under light anesthesia induced with this agent, and this explains the sometimes fatal laryngeal spasm that occurs when it is used.[2]

Tribromoethanol solution (avertin®) is the most often used rectal analgesic agent, but it has little place in anesthesia for the surgical treatment of traumatic conditions.

In the last few years curare and curare-like agents were introduced in the field of anesthesia. They produce more or less elective depression of the neuromuscular junctions, thereby causing good muscular relaxation. They produce no amnesia or analgesia and therefore are always used in combination with other anesthetic agents. Since they frequently cause complete transient respiratory paralysis, they should be used only if adequate personnel and equipment are available for the administration of oxygen endotracheally under positive pressure.

3. Methods of Anesthesia.—The types of anesthesia useful in traumatic surgery may be classified as conduction anesthesia, inhalation anesthesia, intravenous anesthesia, rectal anesthesia and combination or balanced anesthesia.

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2. Burstein, C. L.: Effect of Some Short Acting Barbiturates on the Patency of the Glottis, Proc. Soc. Exper. Biol. & Med. **37**:267-268 (Oct.) 1937.

Conduction anesthesia comprises local infiltration, regional block, nerve block, epidural and caudal anesthesia, spinal anesthesia and refrigeration anesthesia. The employment of local infiltration and regional block, often used in the reduction of closed fractures or the suturing of tissue lacerations, does not need much comment. Caudal anesthesia has not been used frequently in cases of trauma. The use of nerve block is gaining increasing popularity in the surgical treatment of traumatic conditions. It has proved useful in cases of injury of the head, face, jaw and neck, in which close relationship with the upper airways often makes it desirable to work on a conscious patient. It is also useful in injuries involving the upper extremities. Brachial block anesthesia makes it possible to work in comfort on patients who still maintain to some extent the voluntary muscle movements of the involved area, which is helpful in cases of injuries of the tendons and nerves.

In traumatic surgery, spinal anesthesia should be used with great caution. It should be limited to cases involving the pelvic girdle and the lower extremities, and the level of spinal anesthesia should not exceed the tenth dorsal segment. Extensive crush injuries, and possible involvement of the spine, spinal cord or central nervous system, as well as shock and unreplaced loss of blood, are absolute contraindications to the use of spinal anesthesia. The choice of hypobaric and hyperbaric solutions makes it possible to administer the spinal anesthesia with the patient lying on either side, and this is sometimes important in cases of trauma.

Refrigeration anesthesia is carried out by packing the involved limb in chipped ice for several hours. It is mainly used when amputation is to be performed for extensive crush injury, gangrene or overwhelming infection. It not only permits painless performance of the operation but it also minimizes the risk of generalized infection and prevents the absorption of toxins while the patient is being prepared for operation.

Inhalation anesthesia may be administered by the open, semiclosed and closed methods. The so-called open methods comprise the open drop, endopharyngeal and endotracheal insufflation technics. These methods do not require provision for the absorption of carbon dioxide, because the carbon dioxide produced leaves the body easily. The main advantage of these methods is that there is the least resistance in the way of respiration. Disadvantages of the method are that it is wasteful, produces lower oxygen concentration in the inhaled atmosphere and cannot be used with gaseous anesthetic agents. The open method is indicated for extremely young and extremely old persons and for debilitated patients. It is also used extensively for injuries of the head

and brain, in which the use of cautery is important, since the danger of explosion with the open method, especially if air is used as the vehicle for the anesthetic agents, is greatly reduced.

The semiclosed method is a transition between the open and the closed method. It combines some of the advantages and disadvantages of these two methods. It is used extensively in the administration of nitrous oxide–oxygen mixtures to insure a more or less constant nitrous oxide–oxygen concentration. It is also used in the form of the Flagg [3] can in combination with endotracheal tubes. The Flagg can offers little resistance to respiration, and the indications for its use coincide with those for endotracheal insufflation.

The closed method can be used with or without an endotracheal tube. It requires a close-fitting mask or, if an endotracheal tube is used, an inflatable cuff, or thorough packing of the pharynx with gauze can be substituted for the mask. The carbon dioxide produced has to be absorbed by soda lime or barylime absorbers. The advantages of the method are its economy, the ease with which a constant plane of anesthesia can be maintained, its applicability to gaseous anesthetic agents, the high oxygen atmosphere and the possibility of positive pressure anesthesia. Its disadvantages are greater stress on respiration and circulation, greater explosive hazard and greater danger of overdosage in unskilled hands. The closed method might be used with or without an endotracheal tube. The endotracheal tube can be inserted through the mouth or nose. When the injury interferes with a free airway and general anesthesia has to be used, the endotracheal tube is inserted after cocainization of the pharynx and larynx, before the start of anesthesia. It is remarkable how well patients with respiratory obstruction and hypoxia will tolerate the insertion of an endotracheal tube while conscious. The endotracheal tube can be inserted either "blindly" or with the help of a laryngoscope.

In some cases the nature of the injury makes it imperative to insert a tracheotomy tube under local anesthesia before general anesthesia can be started. Even when this heroic measure does not seem to be indicated at the start of anesthesia, a tracheotomy set and a surgeon able to perform a rapid emergency tracheotomy should always be at hand when anesthesia is administered to patients with injuries of the head, face or neck. Injured patients tolerate hypoxia or anoxia badly, and if the insertion of an endotracheal tube is technically impossible at the onset of hypoxia, there should be no hesitation in inserting a tracheotomy tube.

Positive pressure anesthesia is indicated whenever the injury involves the pleural space or when the corrective procedure involves the intentional or accidental opening of the pleural space. Care should

3. Flagg, P. J.: The Art of Anesthesia, ed. 6, Philadelphia, J. B. Lippincott Co., 1939.

be taken that the positive pressure should not be excessive and that it should be administered intermittently. The circulation of the seriously injured patient does not tolerate continuous positive pressure anesthesia over a prolonged period. The important thing is to inflate the lung of the open side intermittently and keep it inflated while airtight closure of the pleura is being carried out.

Some methods of inducing anesthesia which involve transitory respiratory paralysis (curare) might also require positive pressure anesthesia.

Intravenous anesthesia is usually induced by thiopental sodium, and more recently procaine hydrochloride is also being used intravenously to produce analgesia suitable for the completion of minor procedures. Thiopental sodium alone is useful in the surgical treatment of traumatic conditions, but it is even more so in combination with other agents. Induction with this agent is pleasant and swift, and if it is administered properly and over not too long a period, recovery is rapid. It has to be kept in mind, however, that in safe concentrations its analgesic potency is not too high. Pain reflexes originating in the skin are obtunded poorly. For painful procedures, it is advisable to combine it with local or nitrous oxide–oxygen anesthesia. This is especially true with adolescents and vigorous young adults. If painful procedures are attempted with its use alone, often so much has to be used that the patient sleeps many hours postoperatively. The incidence of laryngeal spasm is also much increased if painful procedures are attempted under thiopental sodium anesthesia. Another frequent cause of laryngeal spasm with this anesthesia is manipulation in the region of the head, face and neck. Such procedures should be done under thiopental sodium anesthesia only after the local anesthetization of the pharynx and larynx and the insertion of an endotracheal tube. Equipment and personnel should always be at hand for endotracheal intubation whenever this agent is administered, and a generous dose of atropine or scopolamine should precede its use. The subcutaneous injection of morphine forty-five to sixty minutes preoperatively will also markedly decrease the amount of thiopental sodium necessary.

In recent years, various neuromuscular depressants have gained widespread use in anesthesia. Curare (intocostrin®) and *d*-tubocurarine chloride are the best known of these agents, and dihydro-β-erythroidine has also been used to some extent. They are always used in combination with other anesthetic agents, and it is well to remember that the dose of these agents is much less when used in combination with ether and thiopentothal sodium than if they are used with cyclopropane. Since the margin between the dose producing muscular relaxation and that producing respiratory depression is often small, it is wise to administer

the expected amount in fractional doses and to stop when the necessary relaxation is obtained. The use of neuromuscular depressants without an endotracheal tube is dangerous.

The use of combined or balanced anesthesia is often indicated when the patient is severely injured. The indications of the different combinations will be discussed with the choice of anesthesia for the various procedures.

4. Choice of Agents and Methods.—The safety of the patient, the working conditions of the surgeon and the comfort of the patient, in the given order, are the chief considerations in the choice of the anesthetic agent and method. In choosing the most suitable anesthesia, attention has to be paid to age, physical condition, possible underlying pathologic processes, site of the injury, extent of the surgical procedure, available drugs and equipment and the familiarity of the anesthetist with the different methods. Extremely young and extremely old patients are more sensitive to hypoxia and to depressants of the central nervous system. Certain diseases make the patient especially sensitive toward certain agents; e. g., patients with hypothyroidism or hepatic insufficiency are extremely sensitive to morphine and noncompensated diabetic patients with acidosis are most sensitive to thiopental sodium. It is also a better practice to allow the anesthetist to use a method that would perhaps be a second choice than to make him use agents or methods that might seem to be indicated but with which he is less familiar.

5. Conduct of Anesthesia.—Certain points have to be kept in mind regarding the conduct of anesthesia in the injured patient. Induction should be as smooth as possible because excitement, straining, retching or vomiting might start fresh hemorrhage or increase the deformity and trauma present. Thiopental sodium or nitrous oxide and oxygen should be used for induction, and more emphasis should be placed on smoothness than on speed. It is often advisable to give a little thiopental sodium before the administration of the local anesthetic agent. Better local anesthesia can be produced in the quiet patient, and in the end considerably less of this drug and less local anesthetic agent will be used than if the process had been reversed.

The injured patient should be carried in the lightest possible plane of anesthesia. This can be done satisfactorily by the judicious combination of the various agents and methods.

It cannot be emphasized too often that the injured patient needs adequate oxygenation. The agents used have to be so chosen that at least 20 per cent oxygen, but preferably more, should be in the inhaled atmosphere. The use of nitrous oxide in concentrations greater than 80 per cent is not permissible. If there is any respiratory obstruction,

this should be corrected immediately by changing the position of the patient and inserting a pharyngeal airway or, if these methods do not relieve the obstruction, by the use of an endotracheal tube or, in extreme cases, tracheotomy.

Adequate relaxation should be provided during the operation. A struggling surgeon cannot do the best job, and in the end more harm will come to the patient than if better relaxation had been produced by deeper anesthesia or by the use of neuromuscular depressants.

The anesthesia should be so planned that the patient should recover consciousness shortly after the end of the operation.

Special attention should be given to the circulation during anesthesia. Eventual loss of blood should be replaced at once. Injured patients often go into shock again in the course of operation. This should be recognized and combated by the administration of a judicious combination of blood, plasma and dextrose solutions. If the patient is in shock, the administration of the anesthetic agent has to be decreased or discontinued.

6. Possible Complicating Factors.—One of the most frequent complicating factors is hypoxia. This can be due to mechanical interference with the airway (obstruction or laryngeal spasm), respiratory depression from injury, the anesthetic agent or method, loss of blood, circulatory failure, lack of oxygen in the inhaled mixture, pneumothorax or reduction of the respiratory surface.

Aspiration of stomach contents, blood, pus or foreign bodies is also encountered in injured patients. This complication might require bronchoscopy before the surgeon can proceed with the corrective procedure.

Operative shock and hypersensitivity to anesthetic agents have been mentioned, and, last but not least, chronic alcoholism must also be remembered. Persons with chronic alcoholism sustain injuries more often than any other group, and bitter experience has shown us that induction of anesthesia in these patients can be exceedingly troublesome, even in the hands of experienced anesthetists.

7. Postoperative Care.—To a certain extent, the immediate postoperative care is also the responsibility of the anesthetist. Patients in shock, or with low blood pressure, should be kept on the operating table in a moderate Trendelenburg position. They should be well covered, and oxygen should be administered. They should be moved only after suitable intravenous therapy has restored their blood pressure to a normal level. To avoid unnecessary moving, their beds should be wheeled into the operating room.

Care should be taken that the patient is left in bed in a position that provides for a free airway. The nursing personnel must be

instructed that the patient should be watched carefully so that a change of position or the removal of the oral or nasal airway will not cause respiratory obstruction. Sometimes bandages applied when an endotracheal tube or pharyngeal airway is still in place may interfere with respiration when these are removed. Postoperative edema of the larynx, bleeding or edema in or around the soft parts of the upper airway may also cause severe hypoxia. If the injury involves the head, face or neck, a tracheotomy set should always be kept at the bedside until the patient is fully conscious and the danger of respiratory obstruction is excluded. Massive atelectasis must be considered and, if present, corrected by suction bronchoscopy.

The anesthetist should prescribe individually the necessary analgesic and sedative agents. The judicious combination of analgesics (morphine) and sedatives (barbiturates) will minimize respiratory depression and provide comfort for the patients with relatively small quantities of drugs. The use of such combinations, instead of the routine use of large doses of morphine alone, should be encouraged.

SPECIAL PART

1. Anesthesia for Injuries of the Head, Face, Jaw and Neck.— Provided that there is no respiratory embarrassment and that no respiratory obstruction can be expected, the anesthesia of choice for these injuries is some form of conduction anesthesia. If local anesthesia, field block or nerve block is to be supplemented by some form of light inhalation or intravenous anesthesia, the latter should be started before the local anesthesia, when the patient is easily accessible to the anesthetist. The patient should be carried into the plane in which the anesthesia is to be maintained and put into the operative position, and the respiration should be checked again. If any respiratory difficulty has developed it must be corrected, if possible, by the use of a pharyngeal airway or by endotracheal tube if necessary. Oxygen should be administered freely either by nasal catheter or by endotracheal insufflation; if the supplementary anesthesia is inhalation anesthesia at least 30 per cent oxygen should be added to the inhaled mixture. The surgeon should rely on the local or block anesthesia and should consider the thiopental sodium or nitrous oxide–oxygen anesthesia as an auxiliary measure.

If there is any respiratory difficulty preoperatively, or respiratory difficulty can be expected in the course of operation, the anesthesia of choice is endotracheal anesthesia. The agent can be endotracheally administered ether or thiopental sodium with endotracheally administered nitrous oxide and oxygen, depending on the type of injury. If the patient's respiratory condition is such that adequate oxygenation can be maintained during induction with ether anesthesia and the

surgeon does not want to use cautery, ether should be used endotracheally. If the condition warrants rapid induction, the endotracheal tube can be inserted under thiopental sodium and curare anesthesia. In this case, however, the pharynx and the larynx should be sprayed under vision with a local anesthetic agent before the introduction of the endotracheal tube. Spraying of the cords with a local anesthetic agent might decrease the danger of bronchial spasm that is sometimes seen with the use of curare.

Whenever an endotracheal tube and thiopental sodium are used together, oxygen alone or nitrous oxide and oxygen should also be administered by the semiclosed method. The endotracheal tube might be introduced through the nose or through the mouth, whichever is more suitable for the contemplated procedure. If an endotracheal tube without a cuff is used, the pharynx should be packed around the tube to prevent aspiration.

2. Injuries of the Chest, Back, Spine and Spinal Cord.—For penetrating injuries of the chest endotracheally administered ether is the anesthetic of choice. Positive pressure anesthesia necessary for the reexpansion of the collapsed lung can be given with an endotracheal tube and a closed system. Some clinics prefer to use cyclopropane instead of ether in their open chest operations, but I feel that although cyclopropane is indicated at times in the average case the use of ether is more advantageous.

Unless there is acute hypoxia, the collapsed lung should be expanded only when the surgeon has access to the pleural cavity. Reexpansion of the lung may start fresh bleeding that might be fatal unless it can be dealt with immediately. The lung should be kept inflated until it regains its normal appearance. After that it should be kept expanded or allowed to collapse as the surgical procedure may require. It should be kept in mind that if the surgeon has to work with a collapsed lung, the operation should be interrupted and the lung expanded for a minute or so every twenty minutes. It should also be remembered that excessive positive pressure is not well tolerated by debilitated patients. No effort should be made to keep the lung fully expanded over a prolonged period. The important thing is to expand the lung fully under vision before the wound in the chest is closed and keep up the necessary positive pressure while airtight closure of the wound is being carried out.

Nonpenetrating injuries of the chest and injuries to the back, spine and spinal cord should be treated according to the principles discussed previously. Whenever possible, some kind of conduction anesthesia should be used, supplemented as necessary with oxygen, nitrous oxide and oxygen or thiopental sodium.

If the operation is to be done in the prone position, it is advisable to use an endotracheal tube. Injured patients tolerate the prone position poorly, and whenever possible the operation should be carried out with the patient on his side or in the semiprone position if the operative field is in the dorsal part of the body.

Another instance in which an endotracheal tube is a necessity is when injury to the cervical region of the spine and the cord is present. The endotracheal tube should be inserted with great caution, without changing the position of the head in any direction. Whenever possible, the surgeon should be present at the intubation and should be consulted as to the change in position advisable. If the intubation cannot be carried out easily, it is far better judgment to use a tracheotomy tube than to risk the patient's life by further attempts.

Spinal anesthesia should be avoided in all cases in which the spine, spinal cord or brain is, or might be, injured. If the spinal tap reveals any abnormality in a case in which it was not suspected, the anesthesia should be changed.

3. Injuries of the Upper Limbs and the Shoulder Girdle.—The anesthesia of choice for operations on the arm and hand is brachial plexus block. Wrist block or elbow block can also be used if the injury is below the corresponding level. For extensive operations on the shoulder girdle the use of general anesthesia, often with an endotracheal tube, is necessary.

Closed reduction of fractures and dislocations can be satisfactorily carried out under light thiopental sodium anesthesia. A good practical rule is never to give an additional dose of thiopental sodium in the fluoroscopy room while the lights are out. Local infiltration with procaine hydrochloride often is also of use for closed reduction of fractures.

4. Injuries of the Pelvis and the Lower Limbs.—The anesthesia of choice for operations on the pelvis and the lower extremities after simple injuries is spinal anesthesia. The level of anesthesia can and should be kept low enough to avoid unwarranted side effects due to paralysis of the vasoconstrictors of the splanchnic area. With severe crush injuries of the pelvis and lower limbs involving more than one bone, especially if the patient is in shock due to loss of blood, cyclopropane is the best anesthetic agent.

Because of the frequency of this condition, the anesthetic management of patients with a fractured hip should be considered in a little more detail. Since this condition occurs mostly in the aged, the effects of trauma are superimposed on debility caused by age and preexistent disease. Because of the danger of pneumonia, there is a tendency to rush the patients into the operating room as soon after the accident as possible. Since the advent of sulfonamide drugs, penicillin and streptomycin, the

danger of pneumonia in these patients has been greatly decreased, and experience has shown that it is a better policy to allow them to recover from the physical and psychologic effects of trauma before undertaking the operative procedure. Often these patients, if not suffering from cardiac failure, have a markedly decreased cardiac reserve which needs attention before operation.

The anesthesia of choice for fractures of the hip is either low spinal anesthesia or the combination of thiopental sodium, nitrous oxide–oxygen and local anesthesia. Premedication should be given sparingly; one half to one third of the regular dose usually will be sufficient. The dose of the spinal anesthetic agent should also be small. Results with the combination of nitrous oxide and oxygen, thiopental sodium and a local anesthetic are gratifying. This combination should be used in the presence of myocardial or coronary disease.

Anesthesia should be induced with a small dose of thiopental sodium and then nitrous oxide and oxygen in a 60 to 40 or a 50 to 50 per cent concentration should be administered by the semiclosed method. The reduction of the fracture can be carried out with ease under this anesthesia. The site of the incision should then be infiltrated with 0.5 to 1 per cent procaine hydrochloride. Usually the amount of thiopental sodium necessary for the whole procedure is well below 0.5 Gm., and the patients awake shortly after administration of nitrous oxide and oxygen is discontinued.

Both the surgeon and the anesthetist must realize that hip nailing, and this is also true for operative procedures on any of the large bones of the skeleton, is apt to result in a severe fall of blood pressure and sometimes in surgical shock. Blood for transfusion should be readily available and should be used prophylactically during the procedure.

In cases of extensive crush injuries, gangrene and anaerobic infections of the lower extremities requiring amputation, refrigeration anesthesia proves to be useful. One of its main advantages is that it decreases the absorption of toxins and thereby improves the general condition of the patient while he is being prepared for operation.

The use of ankle block anesthesia for injuries of the foot also deserves a place in the anesthetists' armamentarium.

5. Burns, Anaerobic Infections, Thrombophlebitis, Phlebothrombosis and Injuries of the Vessels.—The treatment of extensive burns always has been a difficult problem. Despite the enormous progress made in this respect in the last years, the margin of safety is low in handling patients. Experience has shown that for the débridement of extensive burns light thiopental sodium anesthesia is better tolerated than ether. However, this is true only if the thiopental sodium is administered with extra care by a person who fully understands the pathologic changes produced by burns.

Recently procaine hydrochloride has also been used intravenously for the dressing and débridement of burns. I have no personal experience with this method, but those who use it report that these procedures can be carried out with little discomfort on conscious patients under intravenously administered procaine hydrochloride.

In contrast, thiopental sodium anesthesia should not be used in patients with anaerobic infections.

The use of paravertebral sympathetic block has proved to be a valuable adjunct in the treatment of traumatic conditions. Trauma is often accompanied with thrombophlebitis or with phlebothrombosis of the lower extremities. Although sympathetic block will not replace ligation of the superficial femoral veins in thrombophlebitis, its value in the treatment of phlebothrombosis of the deep veins is unquestionable. The prolonged arterial spasm that often accompanies injuries is also benefited by this procedure.

SUMMARY

In summary, it should be emphasized that preanesthetic examination, preanesthetic medication, choice of anesthesia, conduct of anesthesia and postoperative care are equally important corollaries of the surgical treatment of the injured patient. Good oxygenation and the prevention of aspiration of blood and foreign material are perhaps the two most important considerations in the conduct of anesthesia. If the anesthetist remembers that the order of importance is the safety of the patient, making the work of the surgeon as easy as possible and, lastly, the comfort of the patient, then he has done his duty to the seriously injured.

SHORT RADIUS

HENRY MILCH, M.D.
NEW YORK

NORMAL appearance and function of the forearm depends on the existence of freely movable superior and inferior radioulnar articulations, adequate motor power in the musculature of the forearm and the preservation of the normal length relationships between the radius and the ulna. Since pronation and supination of the forearm takes place around an axis which extends from the head of the radius to the head of the ulna, any disproportion in the length of either bone necessarily leads to some disturbance in function of the upper or the lower radioulnar joint.

At the lower joint, the situation is further complicated by the fact that the carpus articulates with the lower end of the radius and not with the ulna. Since the carpus follows the radius, anatomic derangement of the distal radioulnar joint leads to deformity which is characterized by a prominence of the ulnar head on the dorsum of the hand. This has been improperly designated as a "dislocation of the ulna" or a "Madelung-like" deformity of the wrist.

The latter designation is especially to be deprecated since it completely ignores the fundamental difference in the pathologic changes between the two conditions. In discussing Madelung's deformity, Ghormley [1] properly noted that "many cases have been reported which are not true Madelung's deformity, although they present an appearance similar to the condition. These may be cases of old malunited fractures, residual deformity from epiphysitis, or osteomyelitis, dyschondroplasia with radial deformity, congenital malformation of the radius, chronic arthritis and so forth."

Anton, Reitz and Spiegel [2] define Madelung's deformity as an "idiopathic, progressive curvature of the radius due to a dyschondroplasia of the inferior radial epiphysis resulting in a deformity of the wrist giving the appearance of an anterior (or more rarely a posterior) subluxation of the ulnar head." In the more advanced cases there may be secondary adaptational changes in the ulna. Primarily, however,

1. Ghormley, R. K., and Pollack, G. A.: Osteochondrodystrophy of the Inferior Radio-Ulnar Epiphysis (Madelung's Deformity), Proc. Staff Meet., Mayo Clin. **4**:759 (Nov.) 1929.

2. Anton; Reitz, and Spiegel, cited by Ghormley.[1]

the pathognomonic feature of Madelung's disease is the progressive curvature of the radius. This has led to its designation as radius curvus. In its mildest manifestations there is no disparity in length between the two bones, so that the curved radius (radius curvus) may be readily differentiated from the short radius (radius parvus) here under discussion. This can be seen in the following instance.

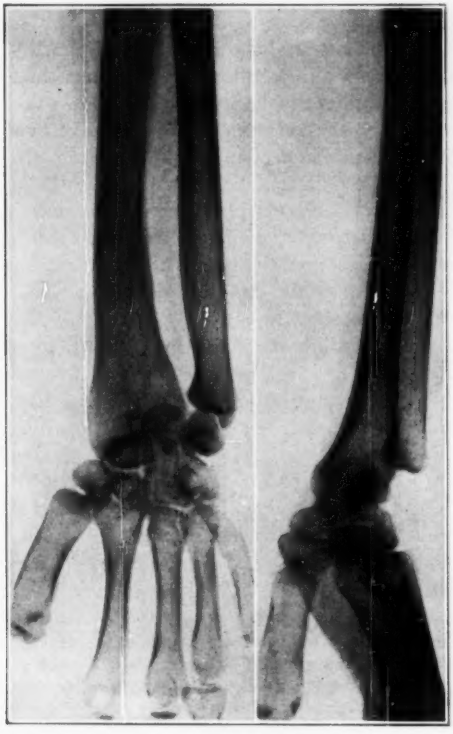

Fig. 1 (case 1).—The left hand is identical in appearance with the right. The ulnar head is at its normal level with respect to the radius. The lower end of the radius is curved forward. The radiocarpal mass is displaced forward, and the position of the ulnar head is similar to that seen in "so-called posterior dislocation of the ulna."

Case 1.—Natividad O., a Puerto Rican aged 24, presented herself for the treatment of bilaterally prominent ulnar heads. There was slight, if any, limitation of function, and the power of grasp was excellent. The roentgenograms of the two hands were practically identical and disclosed an abnormality which had been called "a posterior dislocation of the ulna" (fig. 1). Though the ulnar head

appeared to be displaced dorsally with respect to the radius, it can be observed that it is about at its normal level. On the other hand, the lower end of the radius is curved excessively forward so that the inferior radioulnar joint is disrupted. The carpal mass follows the radius, and therefore "anterior dislocation of the carpus" would much more closely describe the anatomic situation.

It was apparent that the forward displacement of the radiocarpal mass with respect to the ulna could be corrected only by means of a cuneiform shortening of the radius. Since the patient's complaints were entirely of an esthetic nature and there was no impairment in function, operation was not advised.

Madelung's deformity may be simulated by other conditions, and its specific pathogenesis is not fully understood. Bunnell [3] observed that "the deformity is from an epiphyseal growth defect in the lower end of the radius that does not make its presence known until the ages of 10 and 15 with 12 as the average. It is bilateral in two thirds of the cases and four times as frequent in girls. In at least 10 per cent it is hereditary." All these characteristics would seem to indicate something more than simple interference with growth at the inferior radial epiphysis. Even though it may be characterized by a prominence of the ulnar head on the dorsum of the hand, Madelung's deformity must be sharply differentiated from the "so-called dorsal dislocation of the ulnar head" seen in cases of short radius.

Shortening of the radius, or radius parvus, may arise from a number of different causes. The types may be conveniently divided into two groups: those which occur before skeletal maturity has been reached and those which occur after. In the former group it is primarily to those which interfere with epiphyseal growth that attention must be directed. In these it is to be noted that premature closure of the epiphysis may lead to a shortening of the radius and even to an alteration in the direction of the inferior articular surface but seldom if ever to a true curvature of the lower end of the bone. This is seen in the following case.

Case 2 (previously reported [4]).—Toby S., aged 9, was first seen in December 1936, about three months after her wrist had been twisted by a school mate. The earliest roentgenograms taken at another hospital could not be examined, but a report indicated that the child had suffered a volar displacement of the distal end of the radial epiphysis. At the time of her admission there was no evidence of any acute inflammatory signs. The left wrist appeared larger than the right and manifested a sharp volar and radial displacement. The ulnar head was prominent on the dorsal surface, but there was no evidence of weakness of the wrist at this time. The roentgenogram showed a wide metaphysis and an irregular cup-shaped lower radial epiphysis. The volar half of the epiphysis seemed to have undergone premature closure. The dorsal half was narrowed

3. Bunnell, S.: Surgery of the Hand, Philadelphia, J. B. Lippincott Company, 1944, p. 625.

4. Milch, H.: So-Called Dislocation of the Lower End of the Ulna, Ann. Surg. **116**:282 (Aug.) 1942.

but still open, and its growth undoubtedly accounted for the excessive forward inclination of the articular surface. The ulna, unaffected by the earlier trauma, had continued to grow normally and projected downward below the level of the styloid process of the radius.

It was at first believed that the "ulnar dislocation" could be overcome by manipulation. After failure of this ill advised effort, osteotomy was decided on. This too was completely unsuccessful in correcting either the angulation or the disparity in length (fig. 2 *A*). With the continued growth of the child, the dis-

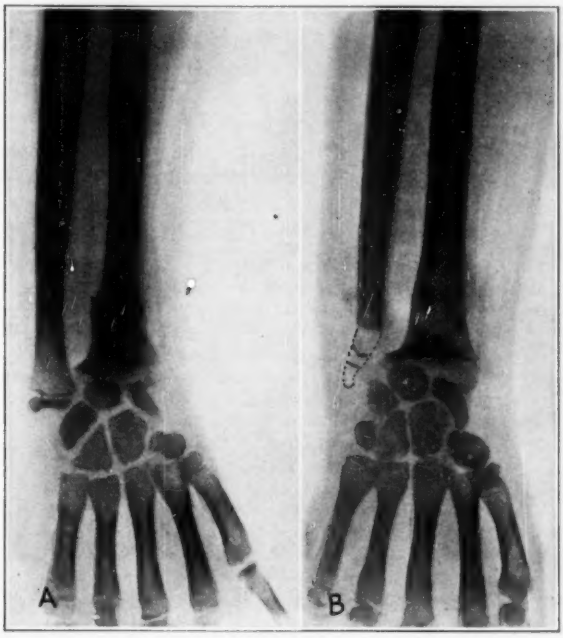

Fig. 2 (case 2.)—*A*, anteroposterior view after osteotomy. The volar angulation can still be recognized. The disproportion in length has not been corrected. *B*, after subperiosteal resection the distal portion of the ulna has regenerated, but because of the presence of the carpus on the same plane, its lower portion has been deflected medially.

proportion in length became progressively greater, and she began to complain of increasing weakness of the wrist, limitation of rotation and a bony prominence on the dorsum of the wrist.

In October 1938 the child was readmitted for treatment of the "so-called posterior dislocation of the ulnar head." Lengthening of the radius did not hold out much hope of success, and it was finally decided to resect the lower end of the ulna according to the method described by Darrach. Immediately after the operation the patient appeared pleased with the disappearance of the lump and the radial deviation of her hand.

Within a short time, however, increasing width of the wrist was again noted, and the roentgenogram offered the explanation (fig. 2 *B*). After the subperiosteal resection of the ulna, the hand was able to resume its normal position. However, as the lower end of the ulna regenerated, the outward pressure of the carpus against the plastic, newly grown tissue caused it to deviate medially, increasing the width of the wrist. In this position it did not impair rotation of the radius since the prominence previously noted on the dorsum of the wrist had been shifted medially and thus could not impinge against the proximal row of carpal bones.

Deformity of an identical nature may arise from ill advised fusions of the radiocarpal joint. Because of the likelihood of danger to the epiphyseal bone, plate fusions of the wrist should be undertaken with the greatest circumspection and if possible should be deferred until epiphyseal growth can no longer be jeopardized. If, however, surgical closure of the radial epiphysis is absolutely indicated, the epiphysis of the ulna should be simultaneously obliterated. Failure to accomplish this must lead to a disproportion in length of the bones of the forearm and the necessity of further operation. This is illustrated in the following instance

CASE 3.—Joseph De L. was brought to the hospital in 1926 at the age of 2. A full term baby, he had been delivered instrumentally and had suffered birth palsy which affected the whole right arm. The earliest treatment consisted of immobilization on an abduction splint and had resulted in a considerable increase in the power of the shoulder girdle musculature. However, despite exercises and electrotherapy, paralysis of the wrist and a flexion contracture of the elbow persisted. To overcome the wristdrop and the contracture at the elbow, the arm was manipulated under anesthesia and a plaster of paris splint was applied. Further treatment was deferred because of the child's age.

In 1933 the patient, aged 9, was again admitted to the hospital for definitive cure of the wristdrop. This was accomplished by excision of the articular surfaces and the sliding of a bone graft from the lower end of the radius across the joint line to the proximal row of carpal bones (fig. 3 *A*).

The result of this operation was far from happy. Arthrodesis was not complete, and though the wristdrop was overcome, the price of this triumph proved unduly great. While the graft had not caused ablation of the radiocarpal joint, it had led to premature closure of the dorsal half of the distal epiphysis. As a consequence, the volar portion continued to grow, causing the inferior articular surface of the radius to point dorsally. This growth was far below its normal rate, so that the ulna soon outstripped the radius in length. The ulnar head became prominent on the dorsum of the wrist and the hand deviated toward the radial side.

The roentgenogram (fig. 3 *B*) was reported as showing "internal and posterior luxation of the ulna." The ulna is slightly longer than the radius. The epiphyseal lines of the radius and the ulna are uneven, that of the radius showing an upward inclination, with partial obliteration of its dorsal portion.

Despite these abnormalities there was relatively little restriction of rotation of the forearm at the inferior radioulnar articulation. This was believed to be due to the fact that after operation a disruption of the inferior radioulnar joint occurred. In consequence of this the

ulna projected downward along the medial aspect of the carpus instead of directly on it. When this occurs the disability due to so-called posterior dislocation of the ulna does not become manifest and equalization of bone length or resection of the ulna is not indicated except for esthetic reasons. The following instance illustrates this.

CASE 4 (previously reported[5]).—Rufus F., aged 38, was seen in 1945 presenting the typical appearance of a bilateral "dislocation" of the ulnar heads. Contrary to what is usually seen in cases of this condition, there was relatively

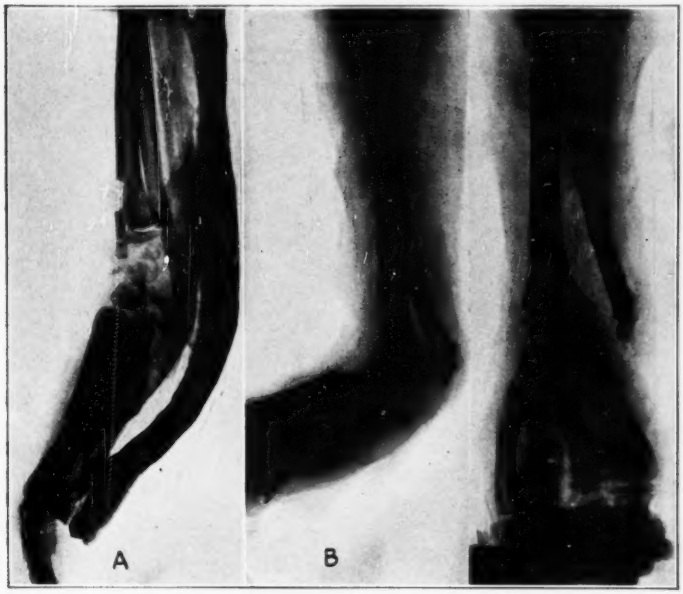

Fig. 3 (case 3).—*A*, roentgenogram in April 1933. Anteroposterior view shows relatively normal length relationship between radius and ulna. On the lateral view the bone graft can be seen extending from the metaphysis across the epiphyseal plate to the proximal row of the carpus. *B*, roentgenogram in November 1936. In the anteroposterior view the ulna is displaced medially and is so much longer than the radius that the styloid process of the ulna is at the level of the distal row of carpal bones. The inferior radioulnar joint has been disrupted, but there is no curvature of the radius. In the lateral view synchondrosis of the dorsal portion of the epiphyseal plate with dorsal angulation of the articular surface is to be noted.

little impairment of the range of rotation or the power of grasp in either hand. The roentgenogram (fig. 4) disclosed a definite shortening of the radius. The lower end of each radius was broad and gave the impression of premature fusion.

5. Milch, H.: Bilateral Ulno-Cuneiform Articulation, Am. J. Roentgenol. **61**:80 (Jan.) 1949.

The sigmoid notch was irregular and clearly had not been articulated with the radial head for many years. The inferior radioulnar joint was completely disrupted and the ulnar heads articulated with what appeared to be facets on the medial aspect of both cuneiform bones. The right radial styloid process was not united and indicated a traumatic origin.

When closely questioned, the patient recalled that as a boy of 10 he had fallen headlong out of a tree and landed on both hands as if he were diving. Apparently no serious damage was noted at the time, because the entire treatment consisted of the application of volar splints. However, serious damage had been done the growing zone of both radial epiphyses, which had apparently been contused or compressed. With the passage of years these epiphyses showed retardation of

Fig. 4 (case 4).—Each radius is shorter than its associated ulna. The lower end of the radius is broad and gives the impression of premature ossification. The radioulnar joint is disrupted, and the ulnar head articulates with the carpal cuneiform on both sides

growth with gradual prominence of the ulnar heads and radial deviation of the hands. Because of lack of any ligamentous injury, the ulna had continued growing downward in its normal plane and had simply displaced the carpus radially. (This is similar to what happened in case 2 after resection of the ulna.) As a result of its constant pressure against the cuneiform bones, new articulations between the ulna and the radiocarpal mass had developed. The action of the inferior radioulnar joint was nullified, and rotary motion which normally occurs at this joint was now carried on accross the ulnocuneiform joint without interference. Because of the absence of any impairment of function and the patient's disregard of the deformity, operative intervention was not deemed justifiable.

In addition to these purely traumatic types, premature epiphyseal closure may be the result of tumor formation, dyschondroplasia or infection. While the disproportion in length to which these epiphyseal conditions lead is striking and frequently progressive in nature, far more common causes for shortening of the radius are to be found in instances in which actual physical shortening occurs.

Among these is resection for fracture of the head of the radius. Watson-Jones [6] noted:

> . . . if the upper end of the radius is too freely excised, it is so much shortened that the relatively long ulna gradually subluxates at the inferior radioulnar joint and pushes the hand over to the radial side. The patient complains of weakness of grip and aching pain in the wrist. In the adult this complication seldom occurs if the excision is confined to the head of the bones, and the neck and orbicular ligament are left undamaged. In children, on the other hand, excision of the head of the radius removes the epiphyseal line. The disproportion in length of the radius and ulna becomes steadily greater as the child grows and a more serious disability develops in the wrist.

Blount [7] has expressed the opinion that "there is no need during childhood for removing the radial head. . . . When the radial head is removed in a young child the inevitable sequel is a deformity of the wrist with radial deviation of the hand, shortening of the radius, weakness and sometimes pain."

Similar shortening may arise from either loss of continuity or angulation as a consequence of fracture of the shaft of the radius.

Case 5.—Sylvia M., aged 22, was seen in 1942. When she was 5 years old, she was involved in some sort of accident which resulted in a fracture of the radius. For the treatment of this, an open operation was performed. Infection developed, and prolonged treatment, with ultimate loss of a portion of the radial shaft, was necessitated. As a consequence of this the hand and forearm were markedly underdeveloped. The ulna, which was shorter than the opposite normal ulna, projected on the dorsum of the hand. The hand was deviated toward the radial side and seemed to jut out from the side of the forearm. There was pronounced limitation of rotation in the forearm, but the power in the fingers was good, so that with the hand in pronation the patient was able to work as a typist. The roentgenogram (fig. 5*A*) disclosed the deformity of the radius, with pseudoarthrosis in the midshaft. The ulnar head projected downward to below the levels of the carpometacarpal joints.

Because of the patient's youth at the time of injury, the ultimate disproportion in length was much greater than that which would have taken place in an adult in similar circumstances. While the esthetic

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6. Watson-Jones, R.: Fracture and Joint Injuries, ed. 3, Baltimore, Williams & Wilkins Company, 1946, p. 474

7. Blount, W. B.; Schaffer, A. A., and Johnson, J. H.: Fracture of Forearm in Children, J. A. M. A. **120**:111 (Sept. 12) 1942.

consequences are proportionately less disturbing, the functional result is qualitatively analogous in nature and the degree of impairment is largely of a quantitative nature.

CASE 6.—Samuel G., aged 45, was seen in October 1945 after an injury to the left forearm some three months before. A neighborhood physician applied a plaster without making any attempt at reduction. Subsequent examination disclosed that the radial styloid process was elevated in relation to the ulnar styloid process.

Fig. 5.—*A*, case 5. There is a large hiatus in the underdeveloped radius at the site of fracture and subsequent infection. Because of the resultant shortening the ulnar head projects downward below the level of the carpometacarpal joints. *B*, case 6. Angulation has resulted in a foreshortening of the radius so that the ulnar head overlies the first row of carpal bones.

In addition there appeared to be a definite lateral bowing of the radius. The roentgenogram (fig. 5 *B*) disclosed angulation, rotation and slight upward displacement of the distal fragments of the fractured radius. This is the characteristic position of fracture occurring below the insertion of the pronator radii teres

and is probably due to the action of the pronator quadratus muscle. Simple refracture with bone suture was unsatisfactory, and the patient was ultimately subjected to bone graft operation.

By all means the most common cause of relative disproportion (shortening) of the radius is inadequate reduction in Colles' fracture. In large part, the unsatisfactory results obtained in the treatment of this most common type of fracture are due to failure to appreciate its complicated character. So much stress has been laid on the correction of the "silver fork" deformity that it has overshadowed the existence and necessity for treatment of other more important deformities. Foremost among these are supination of the distal fragments and relative shortening of the radius. While neglect of the former of these two deformities may lead to a persistence of an apparent dorsal prominence and some limitation of rotation, failure to correct the latter inevitably leads to weakness, pain and unsightly appearance of the wrist.

As in other conditions, the best form of therapy is prophylactic and consists in anatomic reduction of the fracture. In cases in which malunion has already taken place, definitive therapy will depend on the age at which the patient is seen. When epiphyseal growth is still possible, premature ossification of the lower part of the radial epiphysis necessarily forecasts progressive disproportion in the length of the bones of the forearm. In such circumstances, surgical ablation of the unaffected epiphyses will result in a shortening of the forearm and prevention of the disabling inequality characteristic of untreated patients.

For older patients in whom full maturity of the bone has been reached only two therapeutic possibilities exist: lengthening of the affected radius or shortening of the normal ulna. Lengthening of the radius, like the lengthening of other bones, is fraught with many difficulties. When successful, it represents a dramatic surgical triumph, but as a routine surgical practice shortening of the longer bone will be found more generally applicable.

This principle was first employed in 1927 in the following instance.

CASE 7.—Minnie T., aged 35, came to the hospital in 1927, eight years after fracture of the left wrist which followed a fall downstairs. She received no treatment at the time. During the past few years she had noticed gradually increasing pain which she attributed to "change of weather or washing clothes."

Examination disclosed notable prominence of the ulnar head on the dorsum of the wrist. The wrist was deviated to the radial side, and there was definite pain on pronation and supination of the forearm. On pronation the ulnar prominence became less noticeable. Supination was definitely limited by what seemed to be a bony impingement against the lower end of the ulna. The preoperative roentgenogram (fig. 6) disclosed that the whole radiocarpal mass was displaced upward and anteriorly. The head of the ulna, projecting downward, lay on the dorsal surface of the cuneiform bone and during the act of supination acted as a bone block against the dorsum of the carpus. To overcome the

inequality in bone length a Z-shaped piece of bone, with shortening of the ulna, was resected on May 23, 1927. No metallic fixation was employed, and though only incomplete correction was obtained a definite improvement in function resulted.

Credit for the original effort in the treatment of this condition must be given to Darrach. In an article which appeared in the *Annals of Surgery* in 1913 Darrach advised resection of the projecting lower end of the ulna. This operation, which has gained wide recognition, is relatively simple to perform and readily eliminates the objectionable prominence of the ulnar head. It may, however, result in an unesthetic

Fig. 6 (case 7).—Preoperative anteroposterior and lateral views. The shortening of the radius, with anterior dislocation of the carpus and the ulnar head lying on the carpal cuneiform bone, is apparent.

widening of the wrist, arthritis of the radioulnar joint and, above all, a weakening of the wrist due to severance of the ulnar collateral ligaments at the wrist.

Case 8.—Gloria S., aged 17, was first seen in November 1947. Some six years earlier she had fallen and injured her left wrist. The exact damage is unknown, but two years ago a resection of the lower end of the ulna was performed because of pain and interference with motion of the left wrist. For some time after this operation the patient noted an improvement in the function of the wrist. Recently she has begun to complain of pain and swelling of the wrist, with inability to use her left hand normally for writing.

Examination disclosed a small well healed scar over the lower end of the left ulna. Pronation and supination were only slightly impaired by pain but were associated with a definite clicking sensation. The patient complained of a sense of weakness and looseness in the wrist. This was confirmed by the hypermobility of the wrist and particularly of the lower end of the ulna, which could be easily displaced either backward or forward.

The roentgenogram (fig. 8) disclosed a definite malformation of the ulnar head, with hypertrophic arthritic changes at the distal radioulnar joint. To

Fig. 7 (case 7).—After Z-shaped resection of the ulna incomplete correction of the disproportion has been achieved.

strengthen the wrist the patient was fitted with a small protective apparatus. This is of purely palliative value, and it is feared that ultimately the development of painful arthritis may make further operation necessary.

It may be that both the widening of the wrist previously observed and the arthritis here noted are the consequences of technical imperfections. On the other hand, weakening of the wrist by detachment of the ulnar collateral ligaments seems to be unavoidable.

To overcome these defects a true shortening of the ulna in continuity rather than a resection of its distal portion has been suggested.[8] The operation is exceedingly simple from a technical point of view. An incision is made over the subcutaneous border of the ulna, and the shaft is exposed subperiosteally at a distance sufficiently above the tip of the ulna to permit the application of a small Lane plate. The portion of bone to be resected is just sufficient to bring the ulnar head to the level of the lesser sigmoid notch on the radius. The resection may be Z or V shaped or transverse, and thereafter the bone ends are fixed by means

Fig. 8 (case 8).—After resection, the lower end of the ulna is deformed. Arthritis of the inferior radioulnar joint has developed.

of a small four screw Lane plate. The wound is closed, and the extremity is immobilized from above the elbow until roentgenograms reveal bony union at the site of osteotomy.

This operation is technically somewhat more complicated than Darrach's operation but is not excessively trying either to the surgeon or to the patient. Occasionally nonunion of the ulna has been observed. It is believed that this is largely due to the fact that simple suture by

8. Milch, H.: Cuff Resection of the Ulna for Mal-United Colles' Fracture, J. Bone & Joint Surg. **23**:311 (April) 1941; footnote 4.

wire or surgical gut has been employed. Since nonunion is in all probability the result of inadequate immobilization, it is suggested that internal plate fixation be employed. The merit of the method lies in the fact that it abolishes the disabling disproportion in length and eliminates the ulnar prominence without disturbing the anatomic structures which maintain stability of the wrist.

CONCLUSIONS

Attention has been directed to a varied group of cases in which the salient anatomic characteristic is a shortening of the radius. Normal function of the forearm is predicated on the maintenance of normal length relationships between radius and ulna. Shortening of the radius is clinically manifested by a "so-called dislocation of the ulna." This is a misnomer which should be discarded. Disparity in the length of the bones of the forearm should be corrected not by resection of the lower end but by actual shortening of the shaft of the ulna. This permits restoration of function without jeopardizing the stability of the wrist joint.

USE OF SKIN GRAFTS IN REPAIR OF CLEFT PALATE TO IMPROVE SPEECH

HAMILTON BAXTER, M.D., D.D.S.
JOHN DRUMMOND, M.D., D.D.S.
AND
MARTIN ENTIN, M.D.
MONTREAL, CANADA

THE ULTIMATE aim of surgery of the cleft palate is not only to close the defect but to establish normal speech. In the latter objective surgical repair frequently fails, even after adequate periods of speech therapy. In many cases this is due to the anterior pull of the contracting raw surfaces on the nasal side of the mucoperiosteal flap, which results in a "short palate." When healing has occurred, the contracted scar tissue prevents the velum from closing the velopharyngeal sphincter, and so the patient's speech remains defective.

Many ingenious methods have been devised to overcome this fault in the von Langenbeck operation. Advancement of the pharyngeal wall has been advocated and has been effected by such methods as vertical suturing of a transverse incision,[1] formation of pharyngeal flaps,[2] injection of paraffin[3] and insertion of cartilage, but in general these procedures either do not remain effective or are actually harmful.

The concept of lengthening the palate rests on a practical basis, and numerous operations using flaps from the palate, posterior pillars and buccal mucosa and even extraoral flaps have been proposed. Some of these procedures are formidable, others are time consuming and a few result in a high percentage of failures.

Gillies[4] in 1921 reported a method of applying a skin graft to the anterior raw surface of the soft palate after it had been retrodisplaced. The resulting anterior defect in the hard palate he corrected by means of an obturator. Dorrance[5] has termed the obturator "an affront to the surgical mind," and we are in complete agreement with this state-

From the Department of Plastic Surgery, Royal Victoria Hospital and McGill University.

1. Rutenberg, D. C.: Wien. med. Wchnschr. **26**:815, 839 and 862, 1876.
2. Passavant, G.: Arch. f. klin. Chir. **6**:587, 1865.
3. Gersunt, R.: Ztschr. f. Heilk., **21**:199, 1900.
4. Gillies, H. G., and Fry, W. K.: Brit. Dent. J. **42**:293, 1921.
5. Dorrance, G. M., and Bransfield, J. W.: Ann. Surg. **117**:1, 1943.

ment. Anyone who has had experience with growing children and with obturators which must be enlarged yearly realizes that any method which closes the palate completely is preferable to condemning the patient to "obturator life."

In an effort to overcome this difficulty, cleft palates were created surgically on dogs in the Experimental Surgical Laboratories of McGill University in 1940, and experiments were performed to see if grafts of the dogs' oral mucosa could be successfully grown on the nasal side of the mucoperiosteal flaps. This was discovered to be feasible, and in 1941 the method was applied to patients with various types of cleft palate, skin from a hairless area of the body being used.

During the past six years the advantages and some of the technical difficulties of applying skin grafts to the palate have been observed.

The essential principle involved is that of applying an epithelial covering to the raw surface on the nasal side of the mucoperiosteal flap. After the mucoperiosteal flap has been dissected back to the junction of the bony palate and the aponeurosis of the soft palate, dental compound is carefully molded to the space between the hard palate and the mucoperiosteal flap to form a stent. The contour of the stent is oval on cross section, and it should be trimmed until it is somewhat smaller than the cavity into which it will be inserted, so that when the flap is replaced the margins of the wound can be approximated without tension. A split skin graft taken from a hairless part of the body is wrapped, raw surfaces outward, about the compound stent, and the edges are sutured. It is advantageous to use the stent because it serves to keep the skin graft in close contact with every irregularity of the bony palate and mucoperiosteal flap. In addition the skin graft is prevented from contracting until the stent has been removed.

In the usual sequence, "the set-back" procedure is carried out two or three weeks after the application of the skin graft. Formerly it was considered necessary to sever the greater palatine arteries to allow the flap to be sufficiently retrodisplaced, but it has been found in the majority of cases that it is possible to stretch the arteries and veins out of the pterygopalatine canal for a considerable distance, sufficient to make their cutting unnecessary. Occasionally it is necessary to remove part of the posterior wall of the canal and the palatine foramen to avoid kinking of the vessels and to permit the palate to be set back freely, as described by Brown. When removing the bony wall with a chisel, it is most important to avoid damaging the vessels or constricting the artery by compressing the contents of the canal. In a recent case we observed the blanching of the palate, which was considered to be due to vasospasm. This subsided gradually, and no injury to the palate resulted. When this stage of the operation is being performed it is imperative that the skin graft be trimmed away from the margins of

the palatal flap so as to provide a sufficient raw area for union with the posterior part of the palatal bone. The tip of the flap should be securely fixed with wire or dermal sutures to prevent it creeping forward; these sutures should be left in place for several weeks. If the lateral edges of the flap cannot be approximated with sutures, it may be necessary to apply a wire cribwork or an acrylic splint to the teeth to insure primary

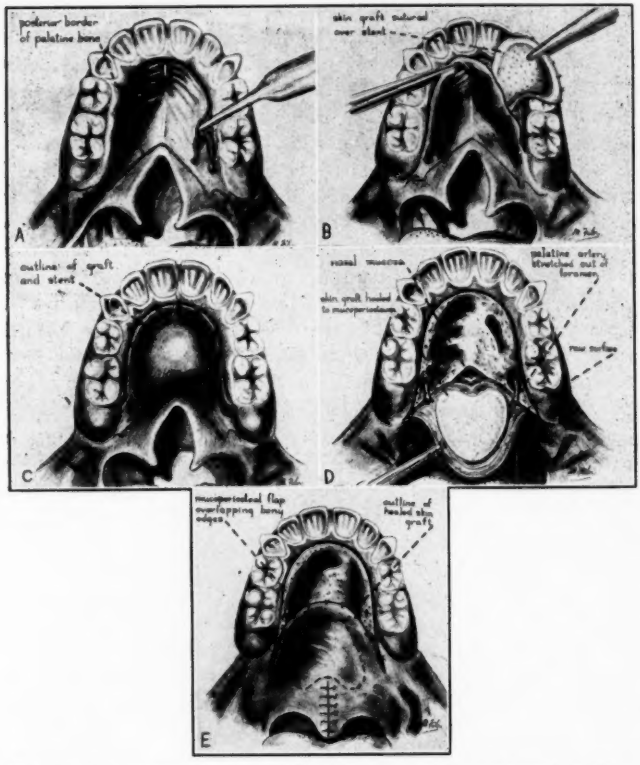

Fig. 1.—*A*, elevation of mucoperiosteal flap, through a U-shaped incision. *B*, insertion of skin graft–covered stent beneath mucoperiosteal flap. *C*, mucoperiosteal flap sutured over stent. *D*, mucoperiosteal flap raised with attached skin graft preparatory to "set-back" operation. The skin graft attached to the palatal bone has been removed. *E*, the retrodisplaced palate flap has been sutured to the posterior border of the palatal bone and the cleft in the palate has been repaired.

union of the edges of the flap. The palatal cleft is closed in the usual manner at the same time that the retrodisplacement procedure is carried out. Palatal massage begun four to six weeks after operation is helpful in mobilizing the palate.

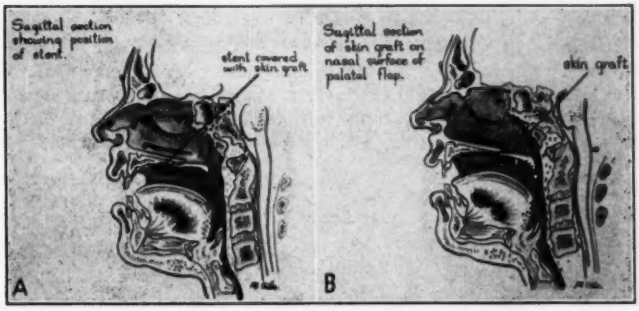
Sagittal section showing position of stent.
stent covered with skin graft
A
Sagittal section of skin graft on nasal surface of palatal flap.
skin graft
B

Fig. 2.—*A*, preoperative position of stent. *B*, postoperative position of skin graft–lined flap.

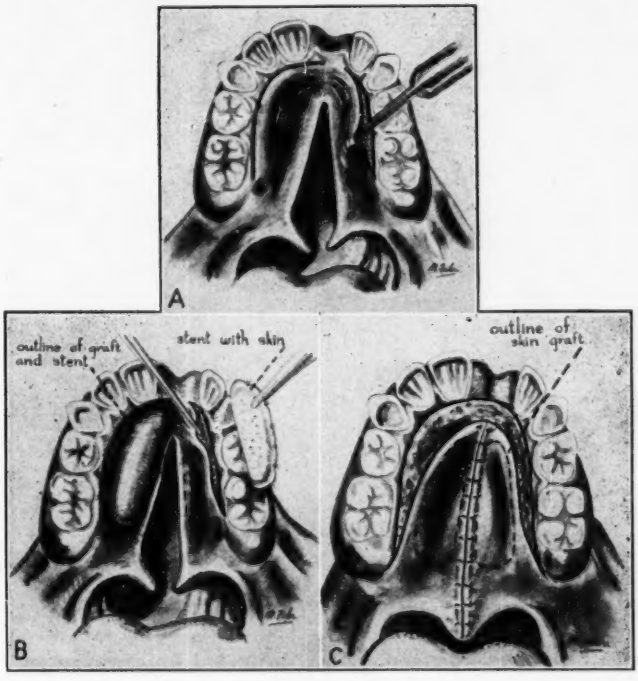

Fig. 3.—*A*, type of incision employed when cleft extends to alveolar ridge. *B*, two skin graft–covered stents are inserted, one on each side of the cleft. *C*, postoperative position of the flap.

METHODS

I. *Congenital Short Palate, Cleft of the Soft Palate and Cleft of the Soft Palate and Part of the Hard Palate.*—In these three types of palatal defect the same method of operation may be employed. A U-shaped incision is made from the molar region of one side around to the opposite molar tooth, about three or four millimeters lingual to the teeth. The mucoperiosteal flap is raised and freed

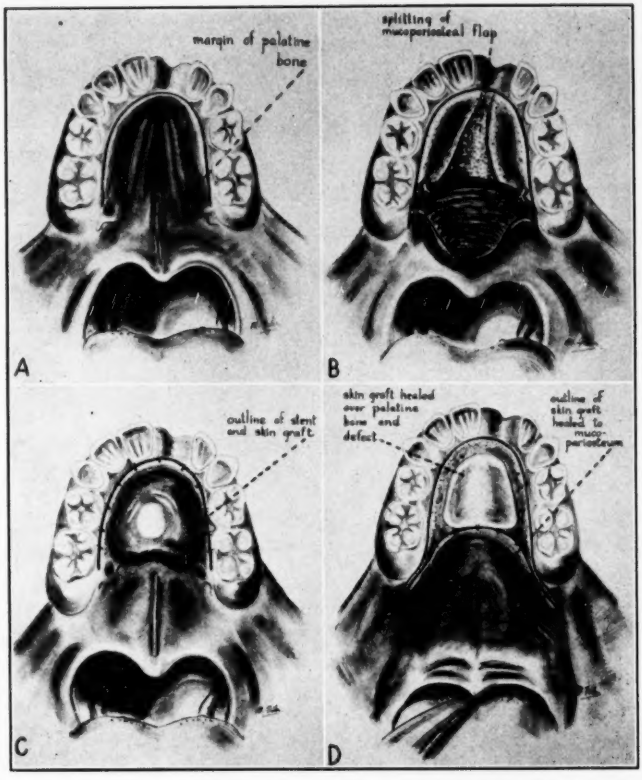

Fig. 4.—*A*, type of incision employed when a short, contracted palate is present after primary repair. *B*, splitting of the mucoperiosteal flap without perforation into the nasal cavity. *C*, mucoperiosteal flap resutured over stent graft. *D*, "set-back" of skin graft–lined flap.

posteriorly as far as the greater palatine arteries and the aponeurosis of the soft palate. Dental compound is shaped to fit the cavity and is trimmed so that the mucoperiosteal flap can be easily approximated over it, allowing for the thickness of the skin graft. The stent is covered with the skin graft, raw surface outward, and is placed beneath the flap, which is sutured over it. Two or three

weeks later the flap is again raised through the original incision line, the stent is removed and the skin graft which has united with the bony palate is stripped off, without injuring the graft on the mucoperiosteal flap. The incision is continued around the tuberosities of the maxilla and some distance posteriorly, the hamular processes divided, the aponeurosis separated from the palatal bone and the vessels carefully stretched out of the posterior palatine canal and freed from the palatal flap as much as possible. If necessary, the posterior walls of the palatine foramens may be carefully cut away with a chisel. The tip of the retrodisplaced flap is sutured with wire or dermal sutures so that it overlaps the posterior border of the hard palate sufficiently to permit solid healing without a perforation occurring (figs. 1 and 2).

II. *Cleft of the Hard and Soft Palate Extending to the Alveolar Ridge.*—In this type of cleft the vomer is frequently rudimentary. As before, an incision is made close to the gingival margin and carried posteriorly as far as the greater palatine foramens. The flaps are raised as shown in figure 3*A*, and in this case two stents are made, one for each side. They are covered with the split skin grafts, raw surface outward, and placed under the flap, one on either side of the cleft. Two or three weeks later the flaps are again raised, the incisions joined anteriorly, the stents removed and the incisions extended posteriorly as before. The skin grafts on the palatal bone are stripped off, the vessels gently stretched out of the posterior palatine foramens and the hamular processes fractured. The palatal flap is displaced posteriorly so that its tip approximates the anterior end of the bony defect and is sutured in position. The cleft is closed in the usual manner. In this type of cleft the retrodisplacement is not as extensive, but the presence of skin grafts on the nasal side of the flaps minimizes the amount of postoperative contracture.

III. *Bilateral Complete Cleft Palate.*—The method described by Dorrance of reflecting flaps of mucous membrane bilaterally from the vomer to close the anterior part of the defect is satisfactory. After the anterior portion has filled in with granulations, mucoperiosteal flaps may be raised, lined with skin grafts and subsequently retrodisplaced (fig. 3).

IV. *Secondary Repairs.*—One of the major problems in surgery of the cleft palate is the patient who has had a single or double cleft repaired by the Langenbeck procedure yet whose speech remains defective because of the short contracted palate. In these patients a "push back" may fail to accomplish the desired speech result because of contracting scar tissue on the nasal side of the flap. In selected cases it may be possible to split the mucoperiosteum without penetrating the nasal side and insert a skin-covered stent and later to retrodisplace the flap in the same manner as that described in method no. 1 (fig. 4).

REPORT OF CASES

The following cases illustrate the method of treatment of various types of palatal defects and the results which have been obtained.

CASE 1.—J. M., aged 6 years, with an intelligence quotient of 82 (normal, 100), had a congenital short palate.

Preoperative Examination.—Cleft palate type of speech was present. The plosives, sibilants and fricatives were all lost, with glottal substitution.

Operations.—1. A stent skin graft was applied to the mucoperiosteal flap. 2. A "set-back" of the palatal flap was performed, and the major palatine arteries were saved. Note extent of the set-back from *A* and *B*.

Postoperative Examination.—After a course of speech therapy, a test showed that the patient's speech was perfect except that the "S" had changed from a glottal stop to a dental lisp (fig. 5).

Nasopharyngoscopic Examination.—The outline of the skin graft to the nasal aspect of the mucoperiosteal flap was easily observed. A considerable degree of metaplasia had occurred, and the graft was pinkish and appeared to be soft and flexible.

CASE 2.—M. F., aged 13 years, with an intelligence quotient of 109, had cleft of the soft palate and half of the hard palate (fig. 6*A*).

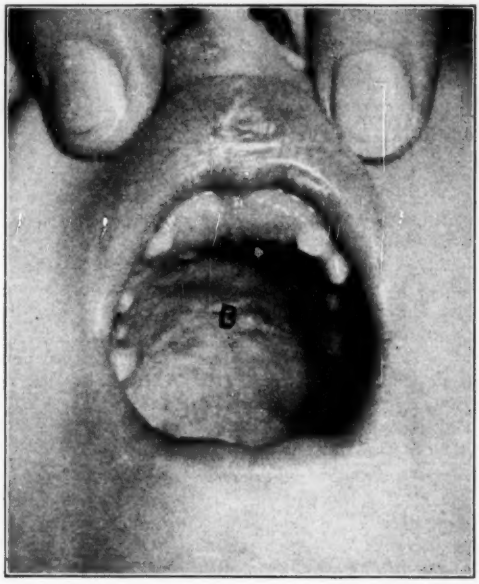

Fig. 5.—Postoperative results, showing marked amount of retrodisplacement of mucoperiosteal flap obtained.

Preoperative Examination: There was a general nasal blur on all vowels. The worst consonants were the sibilants. Nasal grimaces accompanied all these sounds.

Operations.—1. A stent skin graft was applied to the mucoperiosteal flap. 2. "Set-back" of the palate and closure of the cleft were accomplished. The major palatine arteries were saved (fig. 6*B*). 3. Repair of the small hole in the palate (fig. 6*C* and *D*) was carried out.

Postoperative Examination.—At the end of the course of therapy the patient's speech was entirely normal. The only remaining evidence of the facial grimaces was slight nasal twitch on sounding "S."

Nasopharyngoscopic Examination (November 1946).—The skin graft was smooth and flexible and was beginning to undergo metaplasia.

CASE 3.—D. C., aged 6 years, had an intelligence quotient of 100. The diagnosis was cleft of the soft palate and half of the hard palate (fig. 7*A*).

Preoperative Examination.—Cleft palate type of speech was present. The plosives, sibilants and fricatives were all lost, with glottal substitutes.

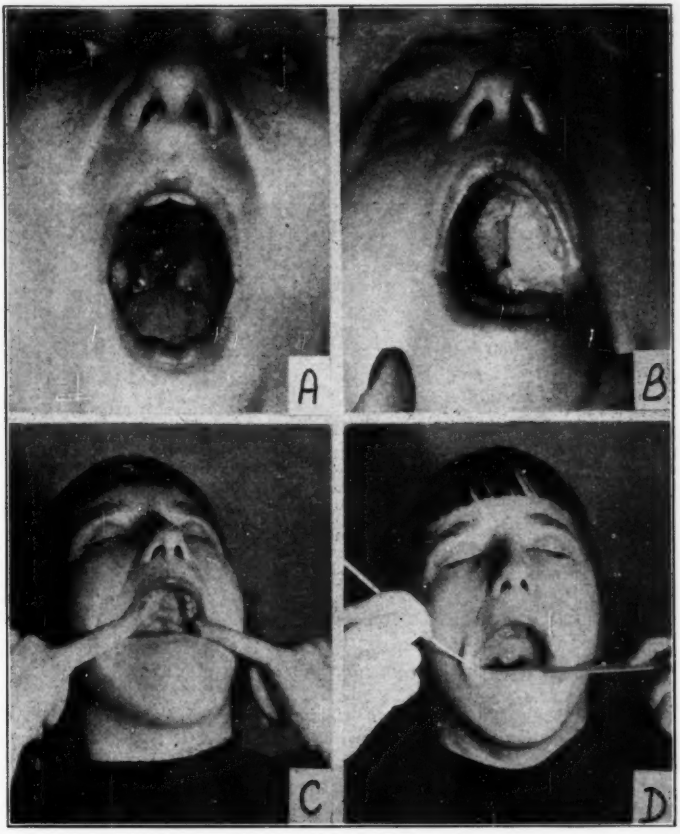

Fig. 6.—*A*, wide cleft of soft palate and half of hard palate with rudimentary vomer, shown preoperatively. *B*, small hole at junction of hard and soft palate, probably caused by inclusion of a piece of skin graft in suture line, which required secondary repair. *C*, showing palate smoothed out and repair of small perforation. *D*, long, mobile soft palate one year postoperatively.

Operations.—1. A stent skin graft was applied to the mucoperiosteal graft. 2. "Set-back" of the palate and closure of the cleft were accomplished. The major palatine arteries were saved (fig. 7*B*).

Postoperative Examination.—The patient is attending a speech clinic. All consonants were articulated perfectly. Some nasal resonance was present on vowels, and there was a low "S."

Nasopharyngoscopic Examination (November 1946).—The skin graft was white and smooth, and no raw areas were visible.

CASE 4.—D. W., aged 13 years, had an intelligence quotient of 100. The diagnosis was previous complete cleft lip and palate on the left side. The lip and palate had been repaired, but the latter was short, and there was a hole in the soft palate. The patient was referred for repair (fig. 8*A*).

Preoperative Examination.—There was over-all general nasal resonance on vowels. The plosives were distorted, with glottal substitutions, and the sibilants and fricatives were glottalized.

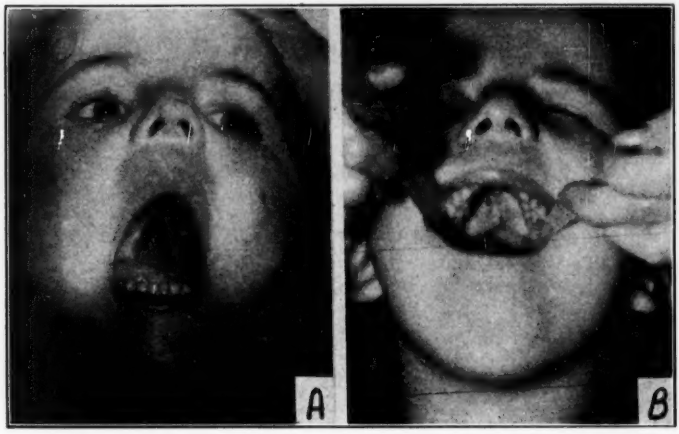

Fig. 7.—*A*, cleft of palate preoperatively. *B*, retrodisplaced skin-grafted flap one month postoperatively, before it had smoothed out completely.

Operations.—1. Stent skin grafts were used to line the mucoperiosteal flaps. The Wardill incision was used anteriorly, while on the posterior half of the hard palate the mucoperiosteal flap was split by the method described by Dr. James B. Brown. 2. Since the major palatine arteries had been severed by the previous operator, a "push-back" of the palate was performed. At the same time the hole in the soft palate was repaired (fig. 8*B*).

Postoperative Examination.—One month after the last operation the patient was admitted to the speech clinic. A test at the time showed that all consonants were articulated perfectly. There was nasal resonance on all vowels, with a velar "K" and "G" and a low "S." The palate was long, and a good speech result was anticipated.

Nasopharyngoscopic Examination (November 1946).—The grafted area appeared as a moist, opaque, white area. There was no crusting, and no raw areas were visible.

CASE 5.—A. W., aged 26 years, had an intelligence quotient of 90.

Diagnosis.—As a result of diphtheria when the patient was 9 years old the uvula and part of the soft palate had sloughed, with extensive residual scarring (fig. 9*A*).

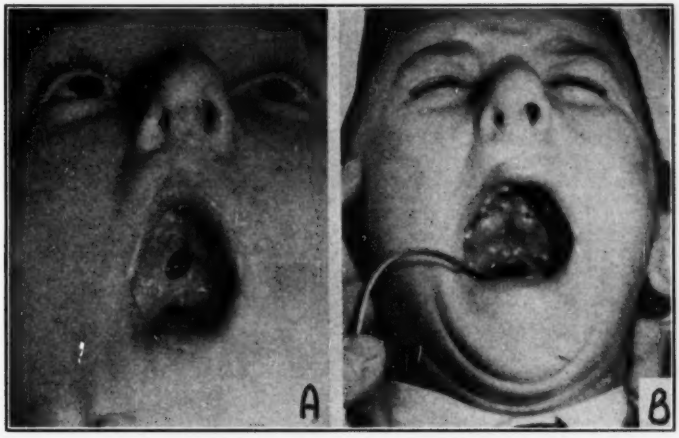

Fig. 8.—*A*, this patient was referred to the clinic for treatment. The previous operator had obtained a short, tight palate with a large perforation in the soft palate. *B*, photograph taken a few weeks after the final operation, showing the amount of displacement backward and closure of the perforation.

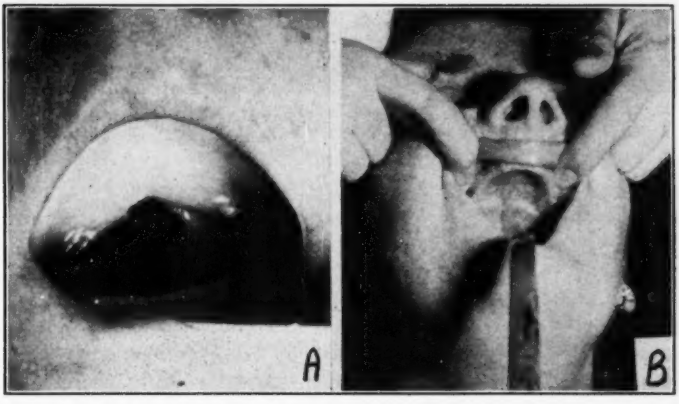

Fig. 9.—*A*, this patient survived an attack of diphtheria as a child but suffered extensive sloughing and scarring of the soft palate. *B*, the tip of the mucoperiosteal flap is shown overlapping the posterior border of the hard palate by only a few millimeters. The patient wears a full denture with comfort.

Preoperative Examination.—There were glottal substitutions for the plosives, and there was nasal resonance on all vowels. The sibilants were nasalized.

Operations.—1. Ligation of major palatine arteries was carried out. 2. A stent skin graft was applied to the mucoperiosteal flap. 3. "Push-back" of the palate flap was performed.

Postoperative Examination.—The patient was unable to attend the speech clinic. Five years after operation the sounding of all consonants was good, although there was some nasal resonance on the vowels. A course of speech therapy is now being given to correct this slight residual defect (fig. 9*B*).

Nasopharyngoscopic Examination (November 1946).—The skin graft could be differentiated from its surrounding mucosa only by a pale whitish tinge.

NOTE.—Because of the pressure of a full upper denture which the patient has been using for the past five years and perhaps because of a process of metaplasia, it

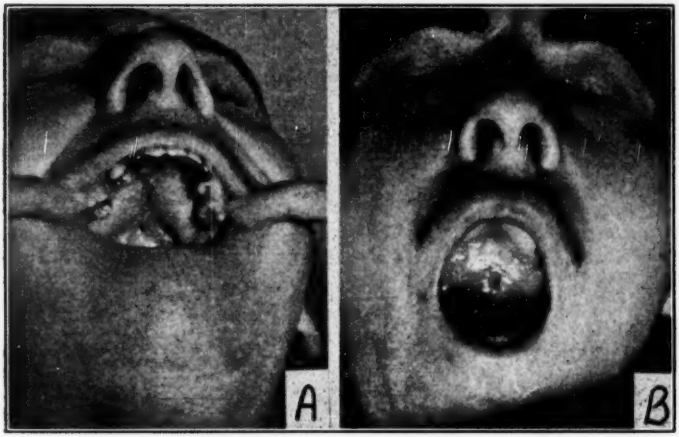

Fig. 10.—Long, noncontracting palate obtained after skin grafting and closure of cleft which extended almost to the alveolar ridge. Two previous operations, with complete failure, had been performed on this patient.

was difficult to recognize the presence of the skin graft which had been applied to the oral surface of the hard palate, and which in this case was not removed.

SUMMARY

Skin grafts have been applied to the nasal aspect of the mucoperiosteal flaps in 22 patients. The skin grafts failed to take in only 3 cases, and in these the operation was successfully completed by a second skin-grafting procedure. Now we use sodium penicillin in isotonic sodium chloride solution, 25,000 units per cubic centimeter injected about the stent and skin graft, before suturing the flap back into position, and in patients in which this has been used there have been no infections. Primary union occurred after closure of the clefts in all except 1 case,

in which a tiny hole 2 mm. in diameter remained, probably owing to inclusion of a small piece of skin graft in the suture line when the cleft was closed. In 2 patients the mucoperiosteal flaps failed to unite primarily at their lateral margins, possibly because of failure to trim the skin graft sufficiently from the margins of the flap. Secure fixation of the flap to obtain close contact of the margins by means of suture, wire crib or acrylic splint is important.

The application of a skin graft to the raw surface on the nasal aspect of a mucoperiosteal flap in selected types of palatal defects appears to be a satisfactory procedure, both theoretically and practically, as far as can be determined from a limited number of cases.

In all patients examined with the nasopharyngoscope the graft was found to be viable and there was no evidence of crusting or offensive odor. Grafts over a year old had assumed a pinkish color, and one graft over five years old had apparently undergone considerable metaplasia, for only a faint whitish tinge differentiated it from the surrounding mucosa.

Some technical complications have been noted after this type of operation, and measures to reduce their incidence have been described.

The results obtained after this procedure for correction of cleft palate and the usual period of speech training were definitely better than those observed after the ordinary type of repair.

This operative method requires an extra stage, and we realize that it is essential to perform each step with painstaking exactitude, for any carelessness or short cuts may jeopardize the success of the whole procedure. However, we believe that this additional care is worth while because we have seen a considerable number of patients who appeared to have long, loose palates after a successful "set-back" or "push-back" operation and in whom, after a few months, so much contracture of the palate developed anteriorly as a result of scar contracture of the raw surface on the nasal side of the palatal flap that even prolonged therapy could not improve their speech. Indeed, a number of these patients have been greatly improved after a subsequent skin-grafting operation.

CONTUSIONS OF THE LUNG FROM NONPENETRATING INJURIES TO THE THORAX

W. C. SEALY, M.D.
DURHAM, N. C.

THE LUNG is subject to damage from nonpenetrating injuries to the thorax. The more severe injuries to the lung, with hemothorax and pneumothorax, have been repeatedly stressed in the literature,[1] but the minor degrees of injury resulting in contusion have received little attention. In an army hospital receiving patients with combat injuries from the army air forces all gradations of injury from contusion to rupture of the lung from nonpenetrating injuries were seen. The agents responsible for the changes in the lung were blast from high explosive shells, blows from blunt objects and nonpenetrating wounds caused by high velocity missiles. Of particular interest, and the subject of this report, were the rapidly clearing areas of pulmonary consolidation noted in some of the cases of injury to the thoracic wall.

Blast injuries to the chest from high explosives have been emphasized in the past war.[2] The accepted explanation for the pulmonary injury caused by blast is the presence of a high positive pressure wave that compresses the chest and abdomen not only by the marked increased pressure but by the force of the wave traveling at tremendous speed. This, then, acts as a blow to the thorax as from a large blunt object. Among the factors that influence the severity of the lesion produced are the amount of padding on the thoracic wall, the position of the chest in relation to the direction of the explosion and the flexibility of the wall. The cases (table 1) reported in the series were from a group of air force personnel exposed to the explosion of approximately 10,000 pounds (4,535 Kg.) of high explosive bombs. Of the 39 patients exposed to the blast requiring hospitalization, 19 had hemoptysis and 9 of these had roentgenologic evidence of pulmonary contusion, 1 had hemothorax

From the Department of Surgery, Duke University School of Medicine.

1. Gardner, C. E., Jr.: Symposium on Aseptic Surgical Technic and Its Application to Thoracic Surgery: Chest Injuries; Application of Military Experience to Civilian Practice, S. Clin. North America **26**:1082, 1946. Deffenbach, R. H.: Management of Certain Pulmonary and Pleural Injuries, S. Clin. North America, **6**:1581, 1926.

2. Zukerman, S.: Experimental Study of Blast Injuries to the Lungs, Lancet **2**:219, 1940.

and cardiac arrhythmia and another had pneumothorax. These patients were all admitted to the hospital within six to eight hours after injury.

Blows to the thoracic wall from blunt objects can cause notable compression of the thorax and result in contusion of the lung, just as in blast injuries.[3] The lung is suddenly compressed by the diminution in the size of the thorax, and the force is transmitted to the lung by its continuity with the wall of the chest. The injured lung in this series was adjacent to the contused wall. There are reports [4] of contra-coup injuries to the lung, most commonly in the posterior portion adjacent to the spine, as well as of injury to the opposite lung. When the chest is injured from blows received in a fast-moving surface vehicle or plane, the absence or presence of contra-coup injuries is hard to determine because of the inability to get a clearcut history of the injury. In none of the cases of simple contusion was there evidence of contra-coup injuries. Table 1 shows a list of the cases in this group studied. The pulmonary changes varied from contusions to rupture of the lung with

TABLE 1.—*Summary of Cases of Nonpenetrating Injuries of the Chest*

	No. of Cases	Hemoptysis	Contusions of Lung	Hemothorax	Pneumothorax	Fractured Ribs
Blast injuries of the lungs...	19	19	9	1	1	0
Wounds of the thorax from nonpenetrating high explosive shell fragments.....	5	3	5	0	0	0
Blows to the thorax from blunt objects.....	16	13	16	7	7	10

hemothorax and pneumothorax. It is of interest that in 1 case without fracture of the ribs hemopneumothorax was present.

High velocity missiles wounding the thoracic wall but not penetrating the pleura may cause injury to the lung by the impact against the wall as well as by the high positive pressure wave that accompanies the missile. Daniel [5] demonstrated in dogs that wounds passing tangential to the chest caused greater injuries than did missiles passing through the lung. He postulated that this was caused by the high pressure wave adjacent to the traveling projectile. Contusion of the underlying lung from this cause was noted in 5 cases presented in this series.

3. Fallon, M.: Lung Injury in the Intact Thorax, Brit. J. Surg. **28**:39, 1940.

4. Wilson, J. W.: Pathology of Closed Chest Injuries, Brit. M. J. **1**:470, 1943. Cooke, W. E.: Traumatic Rupture of the Lungs Without Sign of Trauma in the Chest Wall, Brit. M. J. **2**:629, 1934. Payne, E. M.: Contusions of the Lung Without External Injuries, Brit. M. J. **1**:139, 1909. Westermark, N.: A Roentgenological Investigation into Traumatic Lung Changes Arisen through Blunt Violence to the Thorax, Acta radiol. **22**:331, 1941.

5. Daniel, R. A.: Bullet Wounds of the Lungs, Surgery **15**:774, 1944.

Fractured ribs accompanying the injury to the lung were not always present. In none of the cases with contusion of the lung caused by blast and high velocity shell fragments were there any fractured ribs. In 10 of the 16 cases of contusion of the lung from direct blows fractured

TABLE 2.—*Contusion of the Lungs*

Case	Cause of Injury	Hemoptysis	Roentgenologic Changes in the Chest	Duration of Roentgenologic Changes in the Lung, Days
1	Wound from high velocity shell fragment	Yes, 14 days	Area of consolidation of right mid-pulmonary field	17
2	Wound from high velocity shell fragment	Yes, 2 days	Area of consolidation from hilus to axilla in left upper pulmonary field	3
3	Wound from high velocity shell fragment	No	Area of consolidation at base of right lung	7
4	Wound from high velocity shell fragment	No	Area of consolidation at base of right lung	7
5	Wound from high velocity shell fragment	Yes, 1 day	Area of increased density at lateral aspect of base of right lung	7
6	Large spent shell fragment	No	Area of consolidation of right upper pulmonary field	6
7	Airplane crash	Yes, 2 days	Area of consolidation of both upper pulmonary fields; fracture of ribs 4 and 5 on left and ribs 1, 2, 3, 4 and 5 on right	7
8	Airplane crash	Yes, 3 days	Area of consolidation of both lower pulmonary fields	4
9	Struck in chest with airplane propeller	Yes, 11 days	Hemothorax on right side with consolidated area at base; area of consolidation in left hilar region; multiple fractures of ribs 7, 8, 9, 10 and 11 on left and ribs 9, 10 and 11 on right	11; left residual scar in right lower pulmonary field
10	Hit in right lateral region of the chest in airplane crash	Yes, 2 days	Consolidation of right lower pulmonary field	4
11	Automobile accident	Yes, 1 day	Consolidation of lateral aspect of right lung	8
12	Airplane crash	No	Diffuse mottling of left hilar region beneath fracture of posterior part of left 5th and 6th ribs	8
13	15 feet (457 cm.) from explosion of 10,000 lb. of high explosives	Yes, 3 days	Diffuse areas of consolidation about both hilar regions	5
14	20 feet (609 cm.) from explosion of 10,000 lb. of high explosives	Yes, 2 days	Discrete areas of density of entire left lung and lower half of right lung	5

ribs were present. If the ribs are sufficiently elastic, the lung can be compressed without a break in the costal cage. Some observers [3] have pointed out that in the minor degrees of injury a fractured rib may break the force of the trauma before severe compression of the chest takes place. Of course, in cases of severe trauma of the chest the rib ends may be driven into the lung.

The three types of nonpenetrating trauma to the chest, then, all cause injury to the lung in the same manner: (1) by compression of the semiflexible thoracic wall, (2) by the transmission of the force to the underlying lung by the tissues of the thoracic wall and (3) occasionally by the driving into the lung of fractured ribs. Severe compression of the thorax may result in rupture of the lung and the parietal pleura, with hemothorax or pneumothorax, while less severe trauma

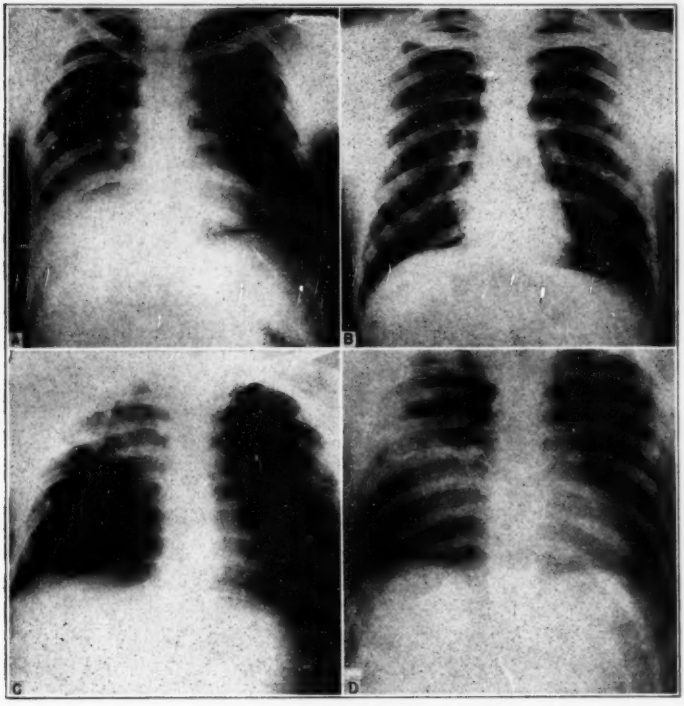

Fig. 1.—*A* (case 3, table 2), roentgenogram on admission of patient with contusion of right lower pulmonary field from high velocity shell fragment in the right lower region of the chest that did not penetrate the pleura. *B*, lung of same patient thirty days later. *C* (case 6, table 2), roentgenogram of patient with contusion of the right upper pulmonary field from blow to anterior region of chest from spent shell fragment. *D* (case 1, table 2), roentgenogram of patient with contusion of the right midpulmonary field from wound caused by high velocity shell fragment that did not penetrate the pleura.

causes only rupture of the pulmonary parenchyma, the latter giving the picture of consolidation on roentgenograms. These areas of consolidation were seen in 14 cases and are recorded in table 2. In 7 cases

they were due to blows to the thoracic wall, in 5 to nonpenetrating wounds caused by shell fragments and in 2 to injury from a high explosive concussion blast. The areas varied in size, as shown in figures 1 and 2. In the cases of direct blows and wounds from high velocity shell fragments, the area of consolidation was adjacent to the injury of the thoracic wall. In a like manner the contusions from the effects of blast were noted in the lung nearest the explosion. In 1 of the 15 cases

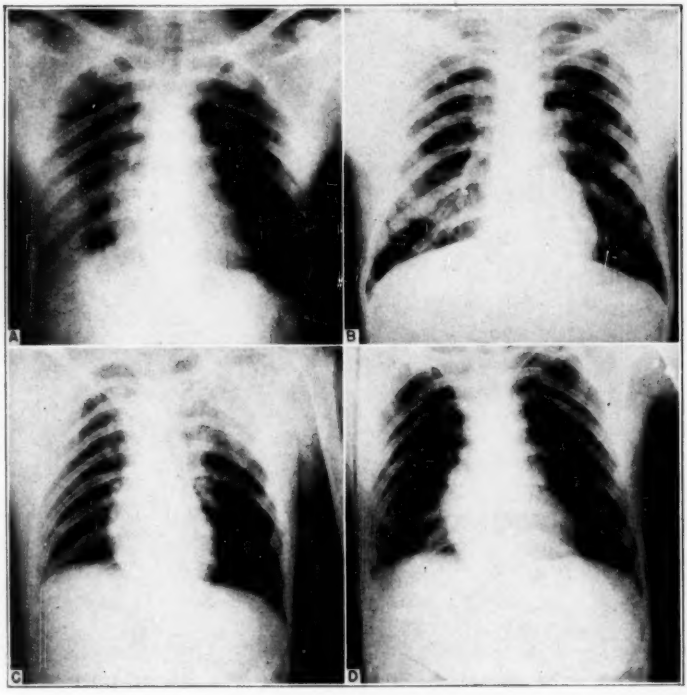

Fig. 2.—*A* (case 10, table 2), roentgenogram on admission of patient with contusion of the right lateral lower pulmonary field from blow caused by blunt force. *B*, lungs of same patient four days later. *C* (case 8, table 2) roentgenogram on admission of patient with contusion of both upper pulmonary fields from injury in airplane crash. *D*, lungs of same patient seven days later.

atelectasis developed in the lower lobe but the area of contusion was in the upper lobe. All patients received prophylactic doses of sulfadiazine and penicillin, and in no cases did pneumonia develop.

Hemoptysis was a prominent symptom in all the cases except 1. In some of the cases there was merely blood-tinged frothy material, while

in others there were frank clots. It is suggested that the multiple areas of increased density seen in some of the cases of blast and the "traumatic wet lung" might be due to flooding of the bronchial tree with blood. The other symptoms were inconstant and were dyspnea, pain in the chest and cough.

The areas of consolidation in the lung demonstrable on roentgenograms were interesting and significant in that they subsided rapidly, the average duration being six days. In some cases the consolidated areas were barely discernible in forty-eight hours. Because of this rapid clearing, it seemed most likely that the density apparent on the roentgenograms was as much the result of edema as of hemorrhage.

As the injuries from blows to the thoracic wall were not peculiar to war conditions, contusion of the lung may occur in civilian practice with more frequency than is generally recognized. A recent report [6] from an industrial plant emphasized the high incidence of lobar pneumonia in workers receiving blows to the thoracic wall. In all the cases presented in this study prophylactic doses of sulfadiazine and penicillin were administered and in none did pulmonary infection develop.

SUMMARY AND CONCLUSIONS

1. The lung may be injured in the intact thorax from any force that compresses the thoracic cavity or which is transmitted to the lung by continuity of tissue.

2. Injuries from the blast wave of an explosion, blows from blunt objects and wounds from high velocity missiles act on the thorax in essentially the same manner.

3. The changes in the roentgenograms of the lungs with the minor degree of injuries are due to contusion of parenchyma followed by edema and hemorrhage.

4. The rapidity of the resolution of the contusion of the lung suggests that the occurrence is more common than is generally recognized.

5. Hemoptysis was the commonest symptom in the cases presented.

6. Phillips, E.: Pneumonia Following Non-Penetrating Pulmonary Injuries, J. A. M. A. **133**:161 (Jan. 18) 1947.

TECHNIC FOR ARTHRODESIS OF THE HIP WHEN THE FEMORAL HEAD AND NECK ARE ABSENT

LEON L. WILTSE, M.D.
LONG BEACH, CALIF.
AND
WALTER A. L. THOMPSON, M.D.
NEW YORK

ARTHRODESIS of the hip joint when the femoral head has been removed or when there is nonunion of the femoral neck with a necrotic head presents certain difficulties not present in other circumstances. The chief of these is in maintaining the trochanter in the freshened acetabulum without placing the lower extremity in too much abduction. Another is in obtaining enough bony contact between the femur and the ilium to assure fusion without an unduly prolonged period of immobilization. Since the upper end of the trochanter is rather small, there is more difficulty placing grafts to good advantage than when the head and neck are present. In the technic to be described, these difficulties have been satisfactorily overcome.

During World War II, a considerable number of patients were seen who had been struck in the hip by a high velocity missile which shattered the neck of the femur. Infection of the wound often followed, and the femoral head and fragments of neck were removed as sequestrums. If infection did not occur, aseptic necrosis of the femoral head, with nonunion, developed in a rather large percentage.

On examination these patients had an average of 1½ to 2½ inches (3.8 to 6.3 cm.) of shortening of the affected extremity due to upward shift at the hip joint. None of our patients was able to walk without crutches or an ischial-bearing brace because of pain and instability in the hip. All had been completely free of drainage for at least five months before a definitive operation was considered.

The choice of procedure seemed to lie between some type of trochanteric arthroplasty and arthrodesis. In the 7 cases on which this article is based arthrodesis was chosen for the following reasons:

1. All the patients had had an infection in the hip rather recently. (The shortest time to elapse between cessation of drainage and arthrodesis was five and a half months and the longest time fifteen months.)

From the Orthopedic Section of the Walter Reed General Hospital, Washington, D. C.

It was believed that the surest way to prevent further trouble from infection was to eliminate motion.

2. All were young men and desirous of a strong pain-free hip which would permit as much activity as possible with a minimum likelihood of further hospitalizations.

3. All had a normal hip on the opposite side, and the lumbar region of the spine was normal.

These patients had been allowed up on crutches, in some cases even before drainage had stopped. This improved their general condition, and since some motion occurred in the hip, it was a fair test of the dormancy of the infection. Physical therapy was given to get the knee and ankle on the affected side as nearly normal as possible before being subjected to another period of immobilization.

OPERATIVE TECHNIC

The patient is placed on a fracture table, with a sand bag under the affected hip. A transfusion of whole blood is started at the time the incision is made and continued throughout the operation, an average of 1,000 cc. being used.

The exposure is obtained by a Smith-Petersen incision,[1] the distal limb of which curves laterally about an inch and a half (3.8 cm.). The anterior portions of the gluteus medius and gluteus minimus muscles and the origin of the tensor fasciae latae are stripped from the lateral surface of the ilium. The space between the tensor fasciae latae and the rectus femoris muscle is located and the incision carried down between these muscles. Then the line of cleavage between the vastus lateralis muscle and the rectus femoris is found, and this is the plane of incision down to the upper end of the shaft of the femur. It is necessary to cut through the upper ends of the origin of the vastus medialis and vastus intermedius muscles.

The sartorius muscle is detached from the anterior-superior region of the spine, the abdominal muscles detached from the iliac crest and the iliacus muscle stripped from the inner aspect of the ilium down to the iliopectineal line. Both heads of the rectus femoris are detached (fig. 1).

The entire upper end of the femur is completely stripped down to the lowest point of the lesser trochanter. The muscle insertions at the tip of the greater trochanter are most easily detached with a sharp osteotome, care being taken to preserve the firm cortex. The leg is then adducted and externally rotated, the upper end of the femur being

1. Smith-Petersen, M. N.: Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana by Means of Acetabuloplasty, J. Bone & Joint Surg. **18**:869-880 (Oct.) 1936.

swung out of the wound, exposing the acetabulum, which is filled with scar or a necrotic head. All scar and cartilage is completely excised down to fresh bleeding bone, including the transverse ligament which bridges the acetabular notch. This is an important step because, unless everything is removed from the inferior portion of the acetabulum, difficulty will be experienced later in getting the shaft over far enough medially. A notch is then made in the upper outer portion of the

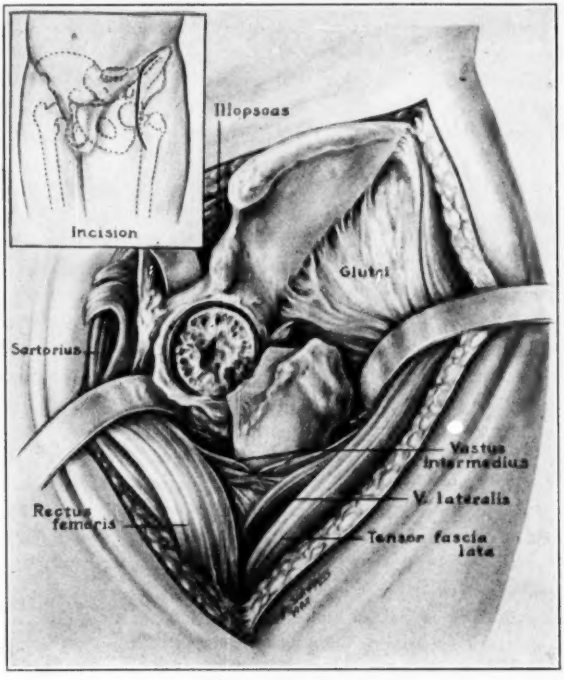

Fig. 1.—Exposure.

trochanter and a corresponding wedge fashioned from the superior rim of the acetabulum (fig. 2). The notch should not be over ⅜ inch (0.95 cm.) deep or the extremity will be unnecessarily shortened. It is often advantageous to cut off the lesser trochanter flush with the shaft so that it will not impinge on the posterior-inferior rim of the acetabulum. The greater trochanter is then placed in the acetabulum (fig. 3) and a Lorenzo screw [2] inserted under direct vision, aiming

2. Lorenzo, F. A.: Molybdenum Steel Lag Screw in Internal Fixation of Fractured Neck of Femur, Surg., Gynec. & Obst. **73**:99-104 (July) 1944.

somewhat superiorly and posteriorly into the thickest, firmest portion of the ilium. In most cases a 3½ or 3¾ inch (8.8 or 9.5 cm.) Lorenzo screw will be long enough. If there is difficulty in retracting the tensor fasciae latae muscle far enough laterally to get the screw started, it may be cut transversely for a few centimeters. No secondary incision need be made. Good stability is present when the screw is tightened down. The position of fixation is 15 to 20 degrees flexion, 5 to 10 degrees abduction and slight external rotation. Flaps of bone are raised from the side of the ilium and upper end of the trochanter and strips of cancellous bone taken from the wing of the ilium and placed

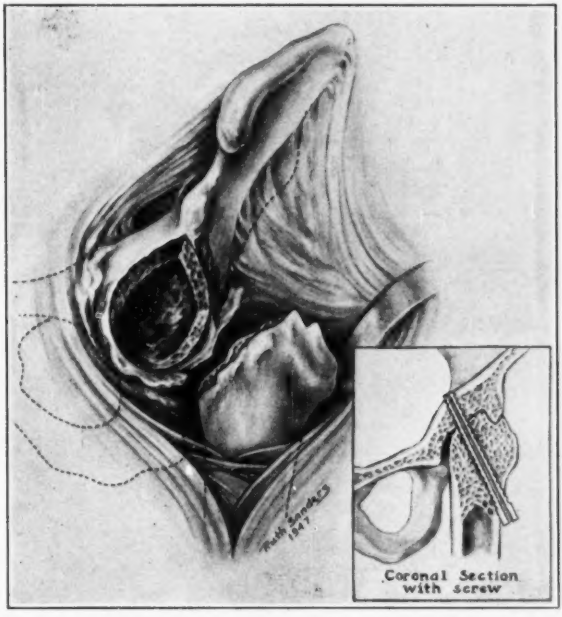

Fig. 2.—Note that the femur is placed directly under the acetabulum. Thus a constant impacting force is in effect.

under the flaps (fig. 3). If there is space between the femur and the deepest part of the acetabulum, this is packed with pure cancellous bone. Cortical bone is not used in this deep area because if postoperative infection should occur, removal of sequestrums would be extremely difficult. Cancellous bone does not form sequestrums readily.

The wound is closed in layers. The rectus and sartorius muscles are not reattached to bone. Since bone has already been removed from the iliac crest and the anterior-superior spine, closure is easy. A one and one-half spica is applied.

POSTOPERATIVE TREATMENT

The spica is kept on until there is definite roentgenologic evidence of union. This will be three to three and a half months. A high single spica with a walking block is then applied and the patient allowed up on crutches until union is secure. Treatment without a cast was considered but not deemed advisable, for although the bone of the ilium is firm and strong that of the upper end of the femur is rather soft, and it

Fig. 3.—Operation completed except for closure.

is doubtful if a screw or a flanged nail alone would maintain the optimum position.

COMMENT

We have used this technic in 7 cases, and enough time has elapsed so that the results can be surveyed. In the first cases a Smith-Petersen nail [1] (fig. 4) was used instead of a Lorenzo screw. It was found that the nail had a tendency to pull out and that even slight motion of the extremity might cause contact to be lost between the femur and the ilium. A Lorenzo screw was then tried and was found to work much

Fig. 4.—*A*, before operation. *B*, six months after arthrodesis using flanged nail.

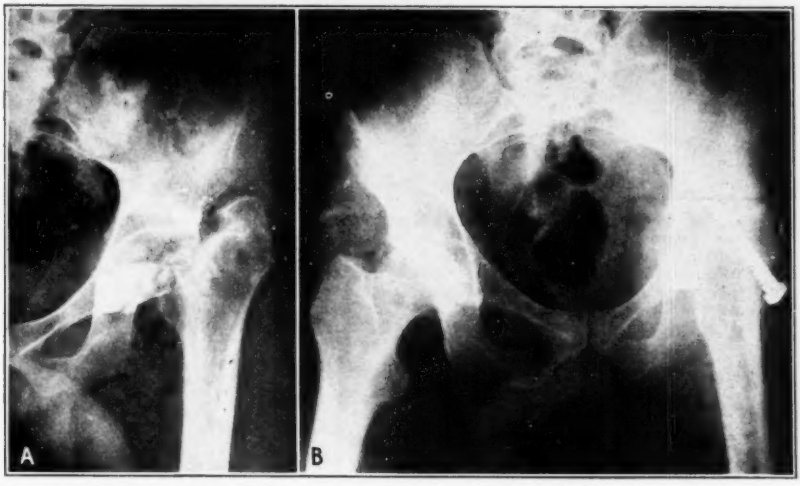

Fig. 5.—*A*, before operation. *B*, six months after arthrodesis using a Lorenzo screw.

better (figs. 5 and 6). Because of the deep threads a secure hold is obtained in the ilium and the bony surfaces can be pressed firmly together. Of the 7 operations done, 6 were successful. Fusion was solid and the patient ready to begin full weight bearing in an average of six months. The first operation performed by this technic represents the only failure. In retrospect the reasons are obvious. The scar tissue was not completely removed from the inferior portion of the acetabulum,

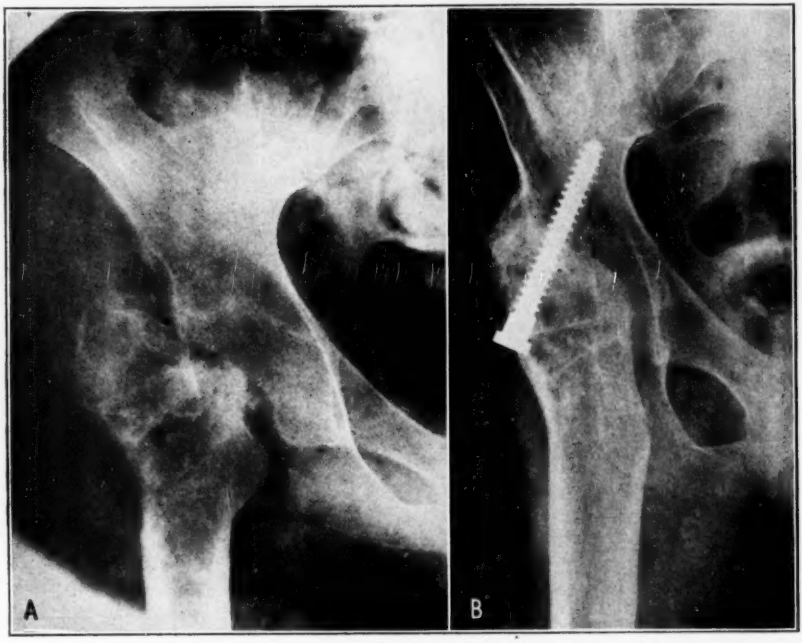

Fig. 6.—*A*, this patient first had a fractured neck of the femur. A flanged nail was inserted, but nonunion resulted. A high abduction osteotomy was done. Fusion occurred between the trochanter and the shaft, but the head remained loose and the hip unstable. Another reconstruction was tried, but infection occurred. The femoral head was removed because it had become a sequestrum. Arthrodesis was performed on March 27, 1947. *B*, roentgenogram taken on Oct. 1, 1947, approximately six months after operation.

and the femur could not be displaced far enough medially. Also, contact was lost because of pulling out of the flanged nail.

In 2 cases purulent drainage occurred postoperatively. Both patients had been heavily infected previously. One had been free of drainage for six months and the other for fifteen months. In the first case drainage stopped spontaneously after four weeks and the area remained dry.

Fusion was solid in the usual time. In the second case draining continued until the metallic internal fixation was removed three months postoperatively, and then it stopped and satisfactory fusion occurred.

Stripping the iliacus muscle from the inner surface of the wing of the ilium makes it possible to insert the screw in exactly the right place under direct vision, with no danger of penetrating too far into the pelvis. It also facilitates the notching of the anterior rim of the acetabulum. Since a cast is applied, this stripping adds little to postoperative morbidity.

There is about 1 to 1½ inches (2.5 to 3.8 cm.) of actual shortening of the extremity due to loss of bone substance. The flexion in which the hip is fused increases the shortening slightly, but some apparent length can be gained by abduction.

We prefer arthrodesis with the extremity in the longitudinal line of the body if there has been little loss of length, but when there is as much as ¾ inch (1.9 cm.) of shortening, some abduction is desirable.[3] However, we believe that the abduction should not exceed 10 degrees or undue strain will be put on the lumbar region of the spine and the knee.

Although the present series is not large, bony union has been obtained in a high percentage when it is considered that failure of fusion in this condition of the hip is notoriously frequent. By the technic described it is possible at operation to place the extremity in exactly the desired position in relation to the pelvis and hold it there until fusion is complete.

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3. The width of the pelvis affects the amount of apparent length that can be gained by abduction (Sedden, H. J.: The Angle of Abduction of the Hip After Subtrochanteric Osteotomy, Lancet **2**:552-555 [Sept. 3] 1938). The pelves of 14 cadavers (9 males and 5 females) were measured. The distance between the centers of rotation of the femoral heads ranged from 15.1 cm. to 18 cm., and the average was found to be 16.5 cm. With the use of this distance, calculations were made with an abduction osteotometer similar to the one described by Milch (Milch, H.: Abduction Osteotometer, J. Bone & Joint Surg. **24**:359-366 [April] 1942), and the following figures were obtained:

Degrees of Abduction of Shorter Extremity	Gain in Apparent Length of Shorter Extremity
0	0.0 cm.
5	1.5 cm.
10	2.9 cm.
15	4.3 cm.
20	5.7 cm.

Since the variaton in width of normal pelves is relatively small, these figures are applicable for practical purposes.

RELIEF OF CHRONIC HYPERTENSION BY EXCISION OF PHEOCHROMOCYTOMA

FREDERICK M. OWENS Jr., M.D.
CHICAGO

THE CLINICAL picture generally associated with pheochromocytoma is one of paroxysms of hypertension with normal blood pressure in the intervals between attacks. That chronic hypertension may be produced by pheochromocytoma is well understood.[1] However, I intend to emphasize the importance of considering such a lesion as a real possibility in all cases of hypertension, especially when the explanation of the symptoms and the hypertension is not completely satisfactory.

The outcome in the patient afflicted with a pheochromocytoma is invariably fatal if the tumor is not removed. The hypertensive crises in those with a history of paroxysms become more and more severe until death results from a violent crisis. The organic cardiovascular changes in the person with chronic hypertension due to pheochromocytoma may not cause death as soon as those which occur in the paroxysmal type, but the outcome is as inexorably fatal. Every precaution must be taken to diagnose the presence of such a tumor in cases of paroxysmal or chronic hypertension in order that a cure may be effected. A diagnosis of diabetes or hyperthyroidism is often made before the true nature of the disease is revealed.

The history may not suggest the presence of paroxysmal attacks, particularly in cases of chronic hypertension. The diagnosis and localization of the tumor is difficult. Both adrenal regions should be explored routinely at the time of sympathectomy for hypertension. However, the tumor may not lie in the adrenal regions but may arise wherever chromaffin tissue is found.

Tests for this epinephrine-producing tumor have been devised to assist in the diagnosis. The first test is the histamine test,[2] in which 0.05 mg. of histamine in 0.5 cc. of isotonic sodium chloride solution or 0.025 mg. in 0.25 cc. of solution is injected intravenously and the

From the Department of Surgery of the University of Chicago.

1. Green, D. M.: Pheochromocytoma and Chronic Hypertension, J. A. M. A. **131**:1260-1265 (Aug. 17) 1946. Soffer, L.; Mencher, W. H., and Colp, R.: Pheochromocytoma of Adrenal Gland, S. Clin. North America **26**:368-381, 1946.

2. Roth, G. M., and Kvale, W. F.: A Tentative Test for Pheochromocytoma, Am. J. M. Sc. **210**:653-660, 1945.

blood pressure is determined every minute after injection. A marked rise of blood pressure (a 110 to 140 mm. rise in systolic pressure and a 30 to 75 mm. rise in diastolic pressure) is reported to follow the administration of histamine in the presence of epinephrine-producing tumors. Such responses are not obtained in patients with hypertensive vascular disease or in normal patients. This test was worked out by Roth and Kvale.

A second "new test" is based on the use of adrenolytic drugs. Goldenberg and his co-workers [3] have reported that benzodioxane causes lowering of the systolic and diastolic blood pressure of patients suffering from chronic hypertension as a result of pheochromocytoma. There is no lowering of systolic or diastolic pressure in cases of hypertensive vascular disease or of arteriosclerotic hypertension. Their experience with this drug in instances of pheochromocytoma and hypertensive vascular disease is such that it promises to be of great value in determining the presence of epinephrine-producing tumors.

Our interest in this subject has been stimulated by recent experience with a young woman suffering from hypertension who was seen at this hospital. Her history was one which might have been given by any person suffering from hypertensive vascular disease, and prior to the time she had been seen here she had been studied carefully and advised to undergo sympathectomy. During the process of study in the clinic for renovascular diseases the patient was admitted to the hospital because of suspected appendicitis. This disease was not present, but during the process of study a mass was felt in the midepigastrium. The discovery of this mass led to the diagnosis.

REPORT OF A CASE

The patient, a white woman 25 years of age, was admitted to Albert Merritt Billings Hospital on Feb. 19, 1947. Her complaints dated back to four years previously, at which time, during an examination for employment, she was told that she had a blood pressure of 150 systolic and 100 diastolic. Since that time she had noted shortness of breath on many occasions, not necessarily related to activity. She believed that she had episodes when she felt excited and nauseated; at the same time she had nervous and anxious feelings. During the past four years she had suffered from severe sweating over the entire body, becoming progressively worse in recent months. In the past year she had experienced dizzy spells accompanied with shortness of breath. These occurred in the morning on arising or at other times of the day, especially when standing, and they were relieved by sitting down. When the attacks occurred in the morning there was associated blueness of the legs.

During the nervous attacks she often had pain over the heart, with radiation. The pain was accompanied with shortness of breath, palpitation and skipped

3. Goldenberg, M.; Snyder, C. H., and Aranow, H.: A New Test for Hypertension Due to Circulating Epinephrine, J. A. M. A. **135**:971-976 (Dec. 13) 1947.

beats. Fainting spells had been frequent in the past four months. She also complained that for six months she had experienced a constant "beltlike" pain in the upper part of the abdomen radiating through to the back.

In June of 1946 she underwent a complete study elsewhere. At that time intravenous pyelograms, a sodium amytal test and renal function tests were made. The patient was advised to undergo sympathectomy for the relief of the hypertension, but she declined this treatment. She was then treated with thiocyanates, papaverine and rutin in conjunction with a low salt diet and psychotherapy. At one time she was told she had diabetes. Systemic examination revealed nothing significant except for the factors noted previously. Her menstrual history revealed menarche at the age of 13, with regular periods occurring each twenty-eight days and lasting five days. The family history was significant in that her father had hypertension and died of carcinoma.

Physical Examination.—Physical examination revealed a well developed, tall, somewhat thin woman of the apparent age of 25 years. The hair was normal, and there were no bony abnormalities of the head. The pupils were round, regular and equal and reacted to light and in accommodation. The fields were normal. The eyes were prominent. The disks were normal. The arterioles were constricted, and the ratio of arterioles to veins was 1:3. No hemorrhages or exudates were present. The ears were normal on gross testing and examination. The nose and mouth were essentially normal. There were no masses in the neck.

The chest was symmetric. There were several areas of small, tender soft nodules on the both breasts. The lungs were clear to percussion and auscultation. Expansion was full and equal.

The heart was not enlarged. An occasional extrasystole was heard. A long blowing systolic murmur, loudest at the apex, was heard through the precordium. The blood pressure was 185 systolic and 125 diastolic.

Diffuse tenderness was present over the abdomen, more on the right side. A mass measuring 2 by 2 inches (5 by 5 cm.) was palpable in the left upper quadrant near the costal margin. It did not move with respiration. Slight enlargement of the right ovary was noted; otherwise the pelvic organs were normal. One large external hemorrhoidal tag was found in the rectum. The extremities were normal. The distribution of body hair was within normal limits.

Laboratory Examination.—Laboratory examinations at the time of admission gave the following results: The specific gravity of the urine was 1.023, and there was a slight trace of albumin. There was no sugar in the urine. Microscopic examination revealed an occasional red cell. The hemoglobin content of the blood was 13.6 Gm. per hundred cubic centimeters, the red blood cell count 4,690,000, and the white blood cell count 7,700. The Wassermann and Kahn tests gave negative results. The nonprotein nitrogen was 21, the urea nitrogen 7.8 and urea clearance 100 per cent of normal.

Other Studies.—Electrocardiographic studies revealed a small Q wave in leads II and III, a low T wave in lead I, an extremely low T wave in lead II and an inverted T wave in lead CF. The report was "myocardial abnormality, with slight tendency to right axis deviation; the axis is unusual for uncomplicated hypertension."

Roentgenograms of the chest, kidneys, stomach, duodenum and colon were normal.

On Feb. 23, 1947, a test with amobarbital sodium (amytal sodium®) revealed an initial blood pressure of 198 systolic and 124 diastolic. The lowest reading was

recorded at six hours; this was 140 systolic and 90 diastolic. At twelve hours the pressure had risen to 170 systolic and 130 diastolic. On February 24 a histamine test [2] gave no response which could be interpreted as indicative of the presence of pheochromocytoma. This should have been repeated with a stronger dose of histamine. The benzodioxane test [3] was not done.

Because of the palpable abdominal tumor with hypertension and a history of attacks which were suggestive of paroxysmal hypertension, it was felt that intra-abdominal exploration was indicated. None of the attacks had been witnessed by any of the attending physicians or nurses.

Operation was undertaken on March 15 under continuous spinal, ethylene and oxygen anesthesia.

Operation.—The abdomen was opened through an upper midline incision. A tumor mass, which was round and firm, was palpated just to the left of the lumbar

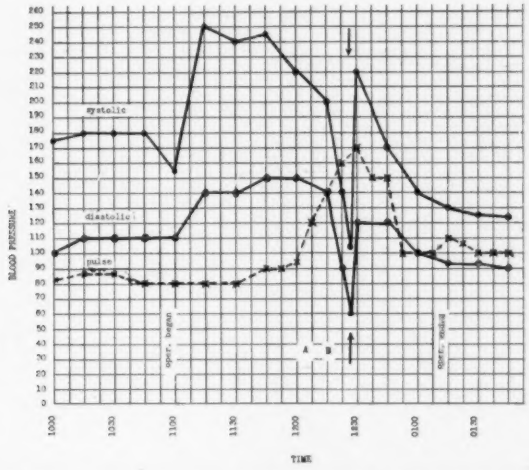

Fig. 1.—Blood pressure readings during operation. Manipulation of the tumor began at *A*. Pedicle of the tumor was clamped at *B*. At the point marked by the arrow the patient received 0.024 Gm. of ephedrine intravenously.

region of the spine at the level of the third lumbar vertebra. Exploration of the right upper part of the abdomen revealed no abnormalities. Both adrenals were explored and were found to be normal. Three small cysts were present in the right ovary.

The tumor mass on the left side of the abdomen was exposed by retracting the jejunum medially. It was then found that it lay in the retroperitoneal tissues directly over the left lumbar sympathetic chain just medial to the ligament of Treitz and against the left side of the aorta. The mass was approximately 6 cm. in diameter, had a firm capsule and was well demarcated from the surrounding tissues. It was copiously supplied with blood vessels on all sides, but the main vessels came from the posterior aspect of the tumor. It was pink and resilient.

The peritoneum was incised over the tumor, and the latter was dissected free from the surrounding tissues, a small amount of areolar tissue being left on its surface. Numerous nerve fibers were found to run into the posterior aspect of the tumor mass from the left lumbar sympathetic chain. During the manipulation of the tumor the blood pressure and pulse rate had steadily increased, so that just before the last vessels were clamped the blood pressure was 220 systolic and 160 diastolic and the pulse rate 160 (fig. 1).

As the main pedicle was clamped the blood pressure fell precipitously to 100 and the pulse rate began to decline. When the pressure reached 100 ephedrine was given intravenously in an attempt to forestall further fall. Response to the ephedrine was prompt, and the pressure finally stabilized at 120 systolic and 96 diastolic and the pulse rate at 100. The postoperative course was uneventful.

The preoperative and postoperative blood pressure readings are graphically represented in figure 2.

The patient was discharged from the hospital in excellent condition twelve days postoperatively. She was followed as an outpatient. One month after her

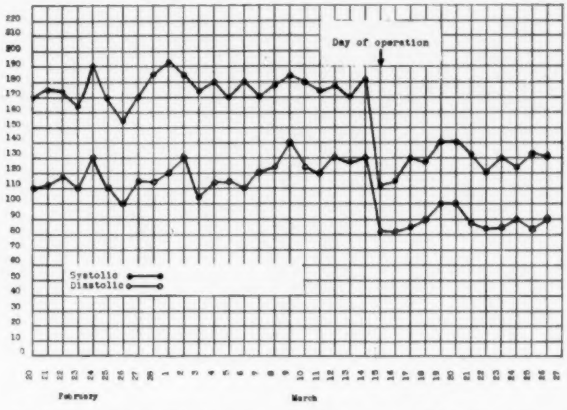

Fig. 2.—Daily average blood pressure readings over a thirty-five day period.

discharge she complained of feeling cold when others about her were hot. Otherwise she felt in good condition. Her basal metabolic rate was +4 and the blood pressure 124 systolic and 94 diastolic.

In September she continued to complain of feeling cold. Her blood pressure was 126 systolic and 94 diastolic. Her general condition was satisfactory. Up to the present time the blood pressure has remained in the vicinity of 124 systolic and 94 diastolic.

Pathologic Report.—Gross Examination: The specimen consisted of a smooth, oval, encapsulated tumor, weighing 65 Gm. and measuring 5 by 4 by 4 cm. The surface was pink and finely fibrous and exhibited adherent tags of ligated blood vessels. The cut surfaces bulged and were soft but elastic and grayish pink. They contained many small pockets containing bloody fluid. When a piece of tumor tissue was placed in 3 per cent potassium dichromate, it quickly turned brown (5 to 10 minutes). After 20 minutes the tumor tissue was brown-black, while the capsule was pale yellow (positive chromaffin reaction).

Microscopic Examination.—This was a vascular cellular tumor, with the cells arranged in trabeculae and nests of widely varying sizes, separated from vascular spaces (fig. 3). Some of these were thin-walled sinuses, others were like venules and others were thin-walled large veins, often surrounded by fibrous tissue. The abundance of the small sinuses was well shown by the Mallory connective tissue stain. The cells were pleomorphic. In some regions they closely resembled normal medullary cells of the adrenal gland. Other cells were large, round or stellate. The cytoplasm of most of the cells was granular, but in some cells there were vacuoles.

In frozen sections the only cells containing coarse sudanophilic globules or granules lay in or near the walls of blood sinuses and appeared to be histiocytes or endothelial cells.

Of special value were slides prepared from the chromated fresh tissue. Four fifths or more of the cells had deep brown cytoplasm, appearing finely granular

Fig. 3.—Microscopic section of the tumor.

under high power magnification. Since only an occasional brown granule (iron or lipochrome) was seen in the formaldehyde-fixed sections, the chromatin must be attributed to the presence of precursors of epinephrine. The cells which were the least chromated were, in general, the large cells with large dark nuclei. No extremely small (primitive) cells or ganglion cells were included within the tumor. However, the fibrous capsule contained nerve trunks, and strung along the nerves were scattered ganglion cells. The sections fixed in Zenker's solution were slightly chromated but much less uniformly than the sections fixed in dichromate followed by dichromate-formaldehyde.

The impression gained was of a characteristic benign pheochromocytoma or chromaffin tumor of sympathetic neural origin arising in the abnormal sympathetic chain, in the vicinity of the Zuckerkandl organ. From the intense chromaffinity, one would expect a high content of epinephrine.

Biochemical assay of the tumor by the Folin method revealed an epinephrine content of 25 mg. per gram of tissue. This represents a total of 1,625 mg. of epinephrine contained in the tumor. By comparison with the epinephrine content of previously reported tumors this represents a high concentration.

The normal adrenal gland contains 1 to 2 mg. of epinephrine per gram of tissue. Other authors have reported assays of tumors revealing anywhere from 1 mg. to 30 mg. of epinephrine per gram.[4] However, the majority of the reports record concentrations of less than 10 mg. per gram.

Why one tumor should cause paroxysmal hypertension and another cause chronic hypertension is difficult to explain. Beer, King and Prinzmetal[5] and also Hyman and Mencher[6] reported demonstrating the presence of a pressor substance in the blood of a patient during a paroxysm. Possibly there is a continuous secretion of epinephrine by the tumor in some persons, but intermittent secretion in others. In dogs it is impossible to create permanent hypertension by continuous infusion of epinephrine for two weeks.[7] Instead of producing hypertension the dose required becomes toxic and kills the dog. Of course the condition is not as chronic in such an experiment as it is in the case of the person with an epinephrine-producing tumor. It is attractive to surmise that the paroxysms result from sudden release of epinephrine from the tumor mediated by the same mechanism as the release of epinephrine from the adrenal glands. Whether or not there may be excess cortical hormone secretion in cases in which there is chronic hypertension is unknown. No cortical tissue was found in sections of this tumor.

It is interesting that prior to removal of the tumor this patient was troubled by excessive perspiration and was always hot but after the removal of the tumor she did not perspire and constantly felt cold. Unfortunately her basal metabolic rate was not determined prior to operation, but two months postoperatively it was + 4. The secretion of epinephrine causes a rise in basal metabolic rate not mediated by the thyroid. It is common to find considerable elevation of the basal metabolic rate in patients with this tumor, and it is possible that during her four years of hypertension the patient had become accustomed to an increased basal rate, so that after its return to normal she felt cold when others were warm.

SUMMARY

A case of chronic hypertension caused by pheochromocytoma and cured by the removal of the tumor is herein reported.

The extra-adrenal location of the tumor emphasizes the fact that exploration of the adrenals at the time of sympathectomy may not reveal the tumor.

Tests for epinephrine-producing tumors are simple and can be utilized to advantage in the study of the hypertensive patient.

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4. Brunschwig, A.; Humphreys, E., and Roome, N.: The Relief of Paroxysmal Hypertension by Excision of Pheochromocytoma, Surgery **4**:361-370, 1938.

5. Beer, E.; King, F. H., and Prinzmental, M.: Pheochromocytoma with Demonstration of Pressor Substance in Blood, Ann. Surg. **106**:80-91, 1937.

6. Hyman, A., and Mencher, W. H.: Pheochromocytoma of Adrenal Gland, J. Urol. **49**:755-776, 1943.

7. Prohaska, J. V.; Harms, H. P., and Dragstedt, L. R.: Epinephrine Hypertension, Ann. Surg. **106**:857-867, 1937.

DRILL PERFORATION, A SIMPLIFIED METHOD FOR VENTRICULAR PUNCTURE

T. C. ERICKSON, M.D.
AND
H. M. SUCKLE, M.D.
MADISON, WIS.

DRILL perforation of the cranium to our knowledge has not been employed in recent years except by a few neurologic surgeons.[1] The simplicity of the method and the rapidity with which it can be carried out make it especially suitable for the emergency treatment of the patient with increased intracranial pressure. At first glance it may be considered hazardous because of possible hemorrhage from ruptured cortical vessels. Our experience, however, indicates that it is safe when performed on patients with increased intracranial pressure and with due regard to anatomic and physiologic factors.

METHOD

Perforation of the skull is performed by the use of a simple twist drill point 2 mm. in diameter (fig. 1). The dura mater can be perforated in a like fashion or by the use of an 18 gage lumbar puncture needle. Since the ventricular needle has little or no leeway in this small opening, it is important that the drill opening in the skull be accurately placed with due regard for the direction to the ventricle which it is desired to puncture.

After the appropriate area of the scalp is shaved and the head positioned, the support under the patient's head is draped with sterile towels and the scalp is sterilized in the usual fashion. The midline is identified by palpation of the external occipital protuberance while the assistant places his extended index finger on the nasion. The sites of the projected drill holes, whether frontal or occipital, are marked with iodine-moistened applicators. For the occipital approach we use a point 6 cm. anterior to the inion and 5 cm. lateral to the midline. These areas are infiltrated with 0.5 per cent procaine hydrochloride solution

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Presented at the meeting of the American Academy of Neurological Surgery, Colorado Springs, Oct. 9, 1947.

From the Department of Surgery (Neurosurgery), University of Wisconsin Medical School and the Wisconsin General Hospital.

1. Dr. W. V. Cone has brought the procedure to a high state of perfection. When we first began to use this method, we received several valuable suggestions from observation of his technic.

containing 5 drops of epinephrine solution (1 : 1,000) in 100 cc., and care is taken to inject it beneath the periosteum. With the use of a sharp-pointed scalpel such as the Bard Parker no. 11, stab wounds approximately 3 to 4 mm. in length are made in the scalp. The blunt end of the no. 7 Bard Parker knife handle is inserted into the wound as a periosteal elevator and separates the pericranium from the skull. Manual pressure is applied to the stab wound with sterile gauze sponges, and the assistant applies counter pressure with his hand on the frontal region. Hemostasis is usually gained within one minute. Only rarely must a silk suture be inserted for hemostasis. The small drill (2 mm. in

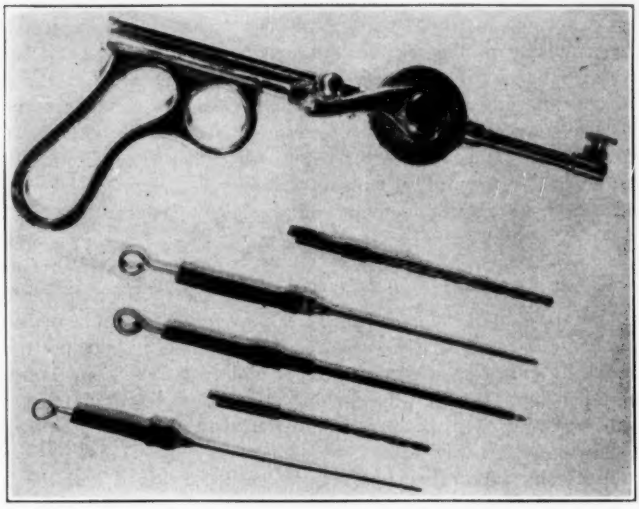

Fig. 1.—Drill handle, twist drill points and ventricular needle used in procedures.

diameter) is customarily used and is carefully directed toward the nasion (fig. 2). During insertion of the drill point, distortion of the scalp is prevented, for this causes difficulty in finding the small drill hole when the ventricular puncture is attempted. Accuracy of the drill direction is maintained, since the narrow size of the drill hole provides little leeway in subsequently altering the direction of the needle.

The drilling is performed with dispatch. The varying resistances of the outer table, the diploic space and the inner table of the skull being distinguished, the dura mater is pierced quickly. Dural penetration may be accompanied with momentary pain, and the operator hears a distinct "pop." The dura mater is penetrated with the drill turning rapidly, for

it is felt that the circular motion of the drill helps seal the encountered vessels. Sudden rapid penetration of the dura with the drill is of utmost importance in avoiding any possibility of extradural hemorrhage. As the drill is removed, there may be a slight gush of blood and cerebrospinal fluid, which usually subsides in less than twenty seconds. Local pressure over the stab wound is avoided at this stage because it is desirable that any slight dural or cortical bleeding be drained externally. If necessary, pressure may be applied below the stab wound over the occipital arteries to control any bleeding from the scalp.

The small ventricular needle is inserted slowly through the drill hole into the brain. The ventricle is usually encountered at a depth of

Fig. 2.—Technic of drill perforation.

5 to 7 cm. Replacement of the ventricular fluid with filtered air or oxygen is then carried out, or if simple ventricular drainage is desired the fluid is allowed to flow out freely.

One advantage of this method is particularly apparent at this stage in that there is less danger of the needle shifting because it is more rigidly held in place by the scalp and skull than in ventricular puncture through ordinary trephine openings.

Because of the simplicity of this method and the rapidity with which ventricular puncture can be carried out, it is especially useful as an emergency procedure. For this purpose we keep available at all times a sterile wrapped tray containing ventricular needles, 2 and 4 mm. drill

points and drill handles as well as the usual syringes, hypodermic needles and sponges.

COMMENT

The drill perforation technic may be regarded as a revival of the brain puncture or ventricle puncture methods practiced more extensively in the early part of the century. Reference to the early literature as well as the discussion of the earlier technic is contained in the book by Krause.[2] Later reference to similar methods is found in an article by Purves-Stewart.[3] No doubt this method fell into disrepute through being employed without due consideration for more definitive treatment. As a blind procedure it has inherent limitations and dangers which must be taken into consideration. However, our experience indicates that it is no more likely to be attended by complication than is ventricular puncture through an open burr hole.

Fig. 3.—Cerebral cortex (left occipital lobe) of patient who died from glioblastoma multiforme seven days after operation, which was preceded by drill ventriculography. The site of puncture is indicated by the arrow.

In reviewing the first hundred cases in which we performed drill perforation with subsequent ventricular puncture, ventriculography or

2. Krause, F.: Surgery of the Brain and Spinal Cord, translated by H. A. Haubold, London, H. K. Lewis, 1910, vol. 1.

3. Purves-Stewart, J.: Triple Puncture: Lumbar, Cisternal, and Ventricular, Lancet **2**:1159-1162, 1925.

cerebral biopsy, we found no case in which a fatality could be ascribed to this procedure. Inspection of the dura and the cortex has been made at subsequent craniotomy and at autopsy. Most of them have shown no visible hemorrhage whatsoever (figs. 3 and 4), the 1 or 2 mm. opening in the dura and the cortex being barely visible to the naked eye. In a few instances there have been small areas, 1 to 3 cm. in diameter, of subdural or subarachnoid hemorrhage. These have never been more than a fraction of a millimeter in thickness, no more than may be seen surrounding punctures done through burr holes made in the course of the more conventional ventriculographic procedures. Extradural, subdural or intracerebral hemorrhage has been occasionally reported with

Fig. 4.—Coronal section of brain shown in figure 3. The needle tract is indicated by the arrow.

the more conventional methods of ventricular puncture. It is theoretically possible that the drill penetration may also cause serious hemorrhage from dural or cortical vessels, but experience indicates that it is unlikely if the site of the procedure is chosen with due regard for the location of the dural and cerebral vessels. The rapidly turning twist drill may be a factor in promoting quick sealing of blood vessels which may by chance be encountered. Sudden penetration of the dura is important in avoiding extradural bleeding. By avoidance of local pressure directly over the drill hole immediately after perforation of the cranium and the dura, bleeding which may occur will be drained extracranially until spontaneous hemostasis can take place. The procedure should no doubt be limited to patients with increased intracranial pressure, for

the higher pressure seals the subdural and subarachnoid spaces sufficiently to prevent appreciable hemorrhage.

The advantages of the drill perforation technic are several. First is its comparative simplicity and the saving of time for the patient and the surgical and nursing staffs. An operating room set-up is not required, and it may be done in the radiology department or at the bedside in an emergency in five or ten minutes. The second advantage is in the reduction of the size of the wound to a small stab wound so that removal of sutures is eliminated and dressings are reduced to a minimum. In the case of suspected glioblastoma multiforme, material for a biopsy may often be obtained through a drill perforation, which confirms the diagnosis and possibly eliminates the necessity of an exploratory craniotomy.

Several subdural hematomas have been diagnosed by this method by the gush of dark old blood when the dura was penetrated. However, in a case of suspected subdural hematoma trephination is without doubt preferable to this technic.

SUMMARY AND CONCLUSIONS

Experience with the technic of drill perforation over a period of four years indicates that it is a valuable adjunct to the armamentarium of the neurologic surgeon in the performance of ventricular puncture and cerebral biopsy. The simplicity of the procedure and the saving of time for the patient recommend it as an emergency procedure. No serious complications have been encountered in over 100 patients, and it may be considered to be relatively safe when carried out with due precaution by a properly trained surgeon. The important details in technic are described, and it is emphasized that it should be employed only in patients with evidence of increased intracranial pressure.

XANTHOMATOUS GIANT CELL TUMORS ARISING IN SOFT TISSUE

Report of An Instance of Malignant Growth

MATHEW W. KOBAK, M.D.
AND
SAMUEL PERLOW, M.D.
CHICAGO

THERE has been considerable controversy about the malignant nature of xanthomatous giant cell tumors arising in soft tissues. Of the lesions noted in tendons and tendon sheaths Fleissig [1] stated that there is no authentic record of metastatic growth. A similar conclusion has likewise been reached by Gomori [2] and Bussebaum [3] and by Berger [4] in a more general appraisal of the problem.

There have been, however, various indications that tumors of this nature may be malignant. Berger [4] cited an example in which local invasive qualities were noted in a growth originating in the thigh. Tourneux [5] reported an instance recorded by Gaudiani wherein a giant cell tumor metastasized to the regional lymph nodes. Similarly, he cited a case described by Dor, who treated a tumor on the index finger diagnosed as sarcoma myeloplaxes. This mass was excised, but it recurred locally and apparently then spread generally. Histologic features simulating those of a malignant process have been reported in specimens observed by King [6] and by De Santo, Tennant and Rosahn [7].

From the Department of Surgery, Michael Reese Hospital.

1. Fleissig, J., cited by Bussebaum.[3]

2. Gomori, G.: Three Uncommon Tumors, Am. J. Surg. **33**:150-156 (July) 1936.

3. Bussebaum, G.: A Contribution on Inflammatory Tumors Presenting the Picture of Malignant Tumors with a Consideration of So-Called Giant Cell Sarcoma of the Tendon Sheaths, Dissertation, Halle-Wittenberg, 1935; abstracted, Internat. Abstr. Surg. **62**:368 (April) 1936.

4. Berger, L.: Synovial Sarcomas in Serous Bursae and Tendon Sheaths, Am. J. Cancer **34**:501-539 (Dec.) 1938.

5. Tourneux, J. P.: Les sarcomes des gaines tendineuses, Rev. de chir. **47**:817-854, 1913.

6. King, E. S. J.: Concerning the Pathology of Tumors of Tendon Sheaths, Brit. J. Surg. **18**:594-617 (April) 1931.

7. De Santo, D. A.; Tennant, R., and Rosahn, P. D.: Synovial Sarcomas in Joints, Bursae and Tendon Sheaths, Surg., Gynec. & Obst. **72**:951-981 (June) 1941.

REPORT OF A CASE

The patient, a 60 year old white man, was first seen in the Mandel Clinic of Michael Reese Hospital on March 18, 1946, complaining of a "lump" on his arm. This had been observed for five months and apparently had evolved slowly without pain. Examination revealed a round mass approximately 3 cm. in diameter on the lateral surface of the arm, just above the elbow. On palpation it was cystic though freely movable. It seemed to be attached slightly to the skin and was neither tender nor inflamed. However, a week later it became infected. The impression at the time was that the lesion was an infected sebaceous cyst, though the possibility of a neurofibroma was not excluded.

By April 4, 1946, the infection had subsided and the mass was easily shelled out. On July 16 a local recurrence of the tumor was noted, and the patient was hospitalized on August 13. Axillary nodes were not palpable. A roentgeno-

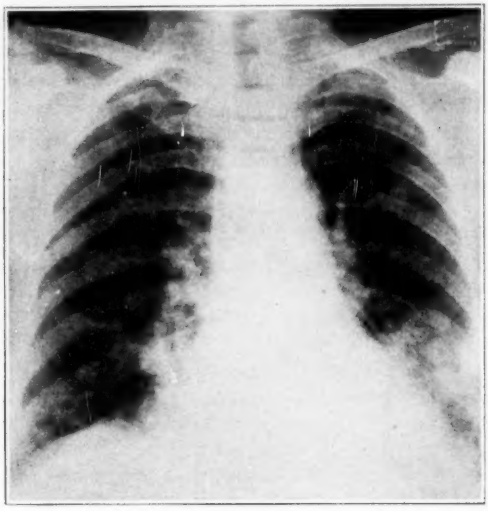

Fig. 1.—Roentgenogram of the chest at time of fourth local recurrence of tumor. Typical sarcomatous metastasis is present in both pulmonary fields.

gram of the chest was normal, and similar study of the elbow region and the humerus failed to show evidence of pathologic change in either soft tissue or bone. On August 15 a block excision of the tumor was performed. The growth was found to extend down to the tendinous insertion of the triceps muscle.

By Sept. 5, 1946, a local recurrence was again present. High voltage roentgen therapy was administered, and the nodule disappeared. Despite this an axillary node was soon noted, and surgical intervention was again advised. Thus on December 23 a radical excision of axillary lymph nodes was performed. Difficulties in healing of the wound were encountered, but it finally healed by Jan. 1, 1947. A second course of radiation was administered.

By April 17, 1947, the mass had again recurred in his arm, and he was coughing. A roentgenogram of the chest (fig. 1) now revealed typical sarcomatous

metastasis. Roentgenotherapy was continued as a palliative measure. On his fourth and last admission to the hospital, Sept. 12, 1947, he had complaints similar to those previously noted, with the addition of dyspnea and occasional hemoptysis. One week after his entrance he experienced severe crushing pain in the chest associated with the feeling of impending death. Diffuse pulmonary rales

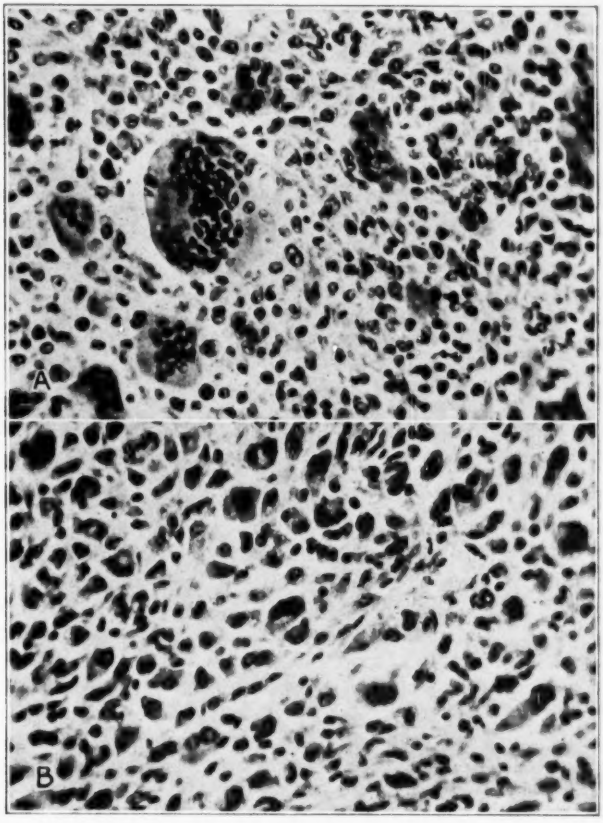

Fig. 2.—*A*, photomicrograph of tumor removed at first excision for biopsy (April 4, 1946) showing multinucleate giant cells and polyhedral and spindle-shaped cells with foamy cytoplasm. In numerous areas atypical mitosis is evident. *B*, photomicrograph of tumor removed at third excision (Dec. 23, 1946). The small cellular elements are more pleomorphic and anaplastic. Atypical mitosis is more evident. × 340.

became audible, and the respiratory and pulse rates increased. He died on the eleventh day in the hospital, and an autopsy was performed.

The report of the various pathologic examinations is as follows:

Grossly, the specimen removed at the first biopsy, on April 4, 1946, is a well encapsulated tumor, 3 cm. in diameter, consisting of several small cystlike areas which communicate with a large central mass. On section the excised tissue is gray-white, with areas of yellow and areas apparently hemorrhagic.

Microscopically (fig. 2*A*) the tumor contains four elements, i. e., polyhedral and spindle-shaped cells with foamy cytoplasm, giant cells, interstitial tissue and patches of fibrous tissue and scattered small accumulations of brown pigment. The smaller cellular elements are of polyhedral and spindle shape and reveal moderate pleomorphism and a number of atypical mitotic figures. These cells possess vesicular nuclei with prominent nucleoli. Their cytoplasm is for the most part foamy in appearance. Giant cells, of the multinucleate variety, are scattered

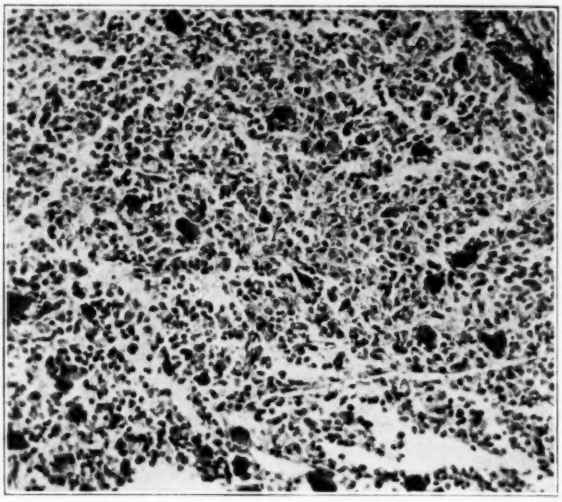

Fig. 3.—Photomicrograph of area of metastasis to lung showing numerous grotesque giant cells, "foam" cells and pleomorphic anaplastic smaller cellular constituents; × 170.

throughout. They present a uniform picture and contain numerous equal-sized nuclei, somewhat large and usually grouped centrally within the cytoplasmic mass. Thin strands of fibrous tissue can be distinguished throughout the tumor mass. In some portions larger patches of fibrosis are present. Small areas of brown pigment, obviously hemosiderin, are present in the interstitial tissue, usually within histiocytes. Capillary channels are present throughout but are not conspicuous. Lymphocytes are scantily dispersed throughout.

This tumor morphologically resembles closely a xanthomatous giant cell tumor of tendon sheath origin. However, the stromal cells exhibit somewhat more anaplasia than is usually encountered in these tumors, and there are a number of atypical mitotic figures present. As far as nomenclature is concerned, the term giant cell sarcoma is perhaps best suited in contradistinction to giant cell tumor.

Histologic examination of the specimen removed on Aug. 15, 1946 reveals much more pleomorphism. The giant multinucleated forms show more variation in size, shape and staining qualities as well as numbers of nuclei. The smaller cellular elements are more pleomorphic and anaplastic. Atypical mitosis is more frequent. The majority of the cells are spindle shaped and have either round or elongated nuclei. Others, however, are large and polyhedral or giant and grotesque in character. Some of these cells possess large nuclei with one or many prominent nucleoli. Others contain several to many nuclei and are indistinguishable from the previously described more anaplastic and smaller multinucleate giant cells. A lymphatic channel is seen to be invaded by tumor. This is a definitely malignant tumor, a sarcoma with giant cells.

The tumor removed at the third excision and dissection of the axillary lymph nodes reveals a picture (fig. 2*B*) similar to that noted in August. However, metastasis to a small lymph node has occurred.

Postmortem examination demonstrates a fungating, dark blue, soft, friable cauliflower mass measuring 12 by 7 cm. on the posterior part of the lower third of the right arm over the insertion of the triceps tendon. Soft bluish tumor nodules, measuring up to 1 cm. in diameter, are scattered over the lateral and medial aspects of the upper third of the right forearm. Similar larger masses are present in the skin of the thoracic wall at the lateral border of the right pectoralis major muscle. The left lung weighs 1,025 Gm. and the right 1,125 Gm. Numerous tumor masses are noted over the surfaces and are palpable within the substance of both. A particularly large mass extends through and into the main left bronchus almost completely occluding this near its origin. From the mucosa in the midportion of the jejunum several dark pink to red nodules project into the lumen. Microscopic sections of all areas of tumor metastasis in the skin, lymph nodes, lungs (fig. 3), bronchi and jejunum are essentially similar to the last biopsy specimen.

COMMENT

Much of the difficulty in determining the qualities of giant cell growths in soft tissues apparently stems from inability to classify these tumors properly. Generally they have arisen in tendon or tendon sheath and have conformed to a pattern that has been variously described as xanthoma,[8] a form of synovioma [4] or giant cell sarcoma.[9]

The question of whether these tumors are malignant or inflammatory has been a chief point of controversy. The concept that they are the former has been based primarily on the fact that infiltrative growth and rapid recurrence have been observed. The lack of metastasis has been taken to indicate the benign nature of the lesion.

Janik,[10] in classifying the sarcomas of tendon sheaths, followed a plan similar to that utilized by Tourneux.[5] In this system the sarcomas are divided into two varieties: (*a*) the sarcoma gigantocellulare (mye-

8. Galloway, J. D. H.; Broders, A. C., and Ghormley, R. K.: Xanthoma of Tendon Sheaths and Synovial Membranes, Arch. Surg. **40**:485-538 (March) 1940.

9. Ragins, A. B., and Shiveley, F. L.: Further Observations on Benign Giant Cell Tumors of the Tendon Sheaths, Ann. Surg. **109**:632-640 (April) 1939.

10. Janik, A.: Tumors of Tendon Sheaths, Ann. Surg. **85**:897-911 (June) 1927.

loma or xanthosarcoma), a benign, lobulated, well encapsulated growth with giant cells, lipoid cells and blood pigments and (*b*) the sarcoma fusocellulare and globocellulare, a malignant neoplasm in which the giant cells and lipoid cells are absent. The latter growth would be akin to the usually described fibrosarcoma.

Other authors [11] more recently have attempted a classification of these lesions based on the origin of the stromal cells. King [6] expressed the belief that the stromal cells are of far greater importance in determining the characteristics of the tumor than the presence of giant cells or xanthoma-like cells. In his concept the giant cells are of the foreign body type and are due to tissue deposits of cholesterol. The foam cells, too, are incidental phagocytes. He concluded that the tendon sheath tumors are neoplastic. Many, though, are of a low grade malignant type with additional inflammatory reaction. The benign forms of growth possess spindle and spheroidal cells, a moderate number of mitotic figures and occasional tissue clefts. The more malignant varieties are like the benign, but the cells are more irregular and embryonic. Many mitotic figures may be seen in these instances. No cases are reported in which this more malignant variety metastasized.

Smith [12] has observed that certain malignant tumors arising from serous bursas, joints and tendon sheaths seemed to possess features in common. The term synovioma was applied to them with the understanding that these growths took origin from the synovial lining cells, the outer fibrous synovial tissue or portions of both of these.

It is considered by many that the benign lesions of tendons likewise are related to the synovia. Berger,[4] for example, stated that the xanthomatous giant cell tumor is related to synovial tumors. He stressed the fact that these giant cell lesions are the result of the histiocytic potentialities of synovial tissue, which may dominate and suppress the endothelial potentialities. The xanthomatous giant cell tumor may thus be considered a synovial histiocytoma.

The term synovial sarcoma has been used by many.[13] It was observed by De Santo and others [7] that these tumors were characterized by (1) endothelial features such as glandlike spaces with mucin, villi and flat epithelium and (2) histiocytic features such as (*a*) reticulum cell sarcoma-like aspects with round or oval nuclei, (*b*) giant cells and (*c*) xanthoma cells similar to those in benign xanthomatous giant cell tumors.

It is the impression of these authors [7] that all synovial sarcomas may be malignant but not equally so. The least malignant show histio-

11. Berger[4]. King.[6] De Santo, Tennant and Rosahn.[7]

12. Smith, L. W.: Synoviomata, Am. J. Path. **3**:355-364 (July) 1927.

13. (*a*) Haagensen, C. D., and Stout, A. P.: Synovial Sarcoma, Ann. Surg. **120**:826-842 (Dec.) 1944. (*b*) Berger.[4] (*c*) De Santo, Tennant and Rosahn.[7]

cytic differentiation and resemble the xanthomatous giant cell tumor. The next most malignant are those with glandlike spaces (which would appear to be like synovioma). The most malignant resemble fibrosarcoma. In this study there were also no reported instances of metastasis from the least malignant variety. However, an intra-articular synovioma (case 11) was described in which areas were found to resemble the benign form of giant cell tendon tumor. This growth eventually metastasized.

Haagensen and Stout,[13a] on the other hand, distinguished between synovial sarcomas and the benign lesions such as xanthomatous giant cell tumors. They adhered to the concept that synovial sarcomas must possess two elements: (1) a fibrosarcomatous element, with spindle cells and (2) a synovial element, often with tissue clefts, villous formation and mucin.

Foot,[14] in discussing tumors of striated muscle, called attention to the fact that the nonmalignant varieties may simulate xanthoma both grossly and microscopically. These myeloblastic tumors have elongated cells, often multinucleated, and usually bear no evidence of intracellular striations. However, the cytoplasm of the giant cells is distinctively acidophilic.

Geschickter and Copeland[15] stated the belief that these tumors are derived from sesamoid bones. The peritendinous portion of the triceps muscle would seemingly be a more logical site in the present case. It is interesting to theorize that despite the absence of synovial tissue in such a flat tendon there is nevertheless a relation between the cellular prototypes which make up the covering of the tendon and those of the synovial structures, as in the hands and feet. The tumor cells could be related to these.

In the case presented here the tumor possessed features which under any classification would have placed it in the more benign variety of lesions. The presence of giant cells and numerous foam cells and the general absence of tissue clefts would seemingly have indicated a benign lesion. Likewise these factors would have differentiated it from the usually malignant synoviomas. However, various features were noted, even initially, which made the pathologists exceedingly wary of the eventual prognosis. Among these were the fact that far more atypical mitotic figures were noted than are seen in the usual benign giant cell lesion. Secondly, there were numerous examples of pleomorphism and grotesque character of the dividing cells. In addition the location

14. Foot, N. C.: Pathology in Surgery, Philadelphia, J. B. Lippincott Company, 1945.

15. Geschickter, C. F., and Copeland, M. M.: Tumors of Bone, New York City, The Lancaster Press, 1936, p. 736.

of the tumor was unusual. Lastly, the rapidity of recurrence pointed toward an eventually poor outcome.

Of further interest is the fact that the pathologists believed that the picture terminally could best be described as one of highly malignant sarcoma with giant cells. However, review of the microscopic sections of the surgical and postmortem specimens still gave the impression, even in retrospect, that the original lesion was essentially identical with xanthomatous giant cell tumor.

In the attempt to form a basis of treatment, it cannot be overlooked that in over 100 cases of xanthomatous giant cell growths noted in the literature there have been, with the possible exception of the cases cited by Tourneux [5] and De Santo and others,[7] no definite evidences of metastasis. Therefore it would seem that for giant cell lesions, and particularly those in the usual locations on the tendons of the hands or feet, a local excision would be indicated. In this regard due emphasis must be given to the histologic nature of the lesion. If the stromal cells possess more mitosis than usual, a more bizzare cell pattern or perhaps unusually large numbers of clefts, then more radical excision and dissection of regional lymph nodes are indicated. Likewise, if the giant cells possess striated myeloblastic character, more extensive measures of therapy would be recommended.

Recurrence of growth following surgical extirpation similarly indicates a need for more energetic treatment. The extent of this must depend not only on the original pathologic findings in serial section but also on the character of the growth as noted in reexcision. In cases in which there are synovioma-like features amputative procedures have been recommended by many.[13a, c] Roentgen therapy has been of little avail in preventing recurrence of these tumors.

SUMMARY

An instance of malignant, soft tissue, xanthomatous giant cell tumor has been reported. This growth originated in the peritendinous portion of the triceps muscle and eventually metastasized widely to the regional lymph nodes, lungs and abdominal viscera. The literature bearing on the subject has been reviewed, and emphasis has been placed on the rarity of such a lesion and on the problems of classification and therapy.

GRANULOMAS OF LARGE SIZE CAUSED BY IMPLANTATION OF TALCUM (TALCUM SARCOIDS)

G. E. GRUENFELD, M.D.
ST. LOUIS

IN MOST hospitals the preparation of rubber gloves involves the use of talcum powder, which is the finely pulverized mineral talc so widely used in industry and in cosmetic preparations. Chemically it consists of a combination of hydrous magnesium silicate, $H_2Mg_3Si_4O_{12}$ (chemically pure talc), calcium magnesium carbonate, calcium magnesium silicate and other related substances in varying proportions. Its usefulness for the servicing of surgical rubber gloves is apparently based on the following properties: (*a*) It withstands easily the heat of the sterilization process. (*b*) It absorbs films of moisture from rubber and skin. (*c*) It eases friction between rubber and skin surfaces by a ball-bearing effect of the minute powder particles. Other substances which could be used for the same purpose have apparently not been widely accepted, so that the field today is still left almost exclusively to talcum powder.

While much fault cannot be found with the purely physical properties of talcum powder, it needs to be emphasized that in contact with living tissue it is, not infrequently, productive of serious reactions in the form of chronic inflammations or tumefactions. This statement might come as a surprise to many surgeons who, during their long and busy careers, have used talcum powder in and on rubber gloves seemingly with complete satisfaction and without untoward results. But there is no question that in some circumstances, at present unknown in their portent, disease processes might be started by the insemination of glove powder into the tissues exposed by surgical intervention. This refers not to any unusually heavy contamination with measurable quantities of powder, but to the minutest, merely microscopic retentions of talcum particles unavoidable even if the surgical team rinses its gloves meticulously after slipping them on.

The sense of security which surgeons derive from the use of rubber gloves has been disturbed by recent warning reports. (See Antopol,[1]

From the Surgical Services of Barnard Free Skin and Cancer Hospital and the Jewish Hospital of St. Louis.

1. Antopol, W.: Lycopodium Granuloma, Arch. Path. **16**:326 (Sept.) 1933.

Owen,[2] Fienberg,[3] German,[4] de Savitsch,[5] Byron and Welch,[6] McCormick and Ramsey,[7] Ramsey,[8] Seelig, Verda and Kidd,[9] Lichtman and others,[10] Eiseman, Seelig and Womack,[11] Roberts [12] and Klemm.[13]) It is not without interest to note that although the evil of irritating dusting powders like lycopodium was described over fifty years ago, it was not until the past few years that any insistence was laid on the necessity of banning the use of talc during surgical procedures. In a recent contribution from the Mayo Clinic, the categoric statement is made that "talcum must go." Seelig and his co-workers, who were the first to attack the problem of finding a substitute for talcum, are still engaged in a search for a dependable and reliable one.

It is my purpose to call attention again to a potential hazard ascribable to a routine surgical technic which is so generally and so erroneously accepted as being entirely satisfactory. I shall take as an example the following incident:

A young woman, aged 21, noticed a painless swelling grown to a conspicuous size in the right lower region of the abdomen for three weeks before presenting herself. Eleven years previously, at the age of 10, she had undergone an appendectomy, a short McBurney incision being used. The operative scar was normal, and she stated that her postoperative recovery had been prompt and that no disturbance in the region of the wound had ever been noticed before. The tumor, so recently observed, developed beneath the operative scar, evidently in the deeper layers of the abdominal wall but leaving uninvolved the overlying skin. This was considerably elevated by the nodular mass, which measured, at the time of her admission to the hospital, approximately 12 by 5 cm. In the opinion of her

2. Owen, M.: Peritoneal Response to Glove Powder Containing Talcum, Texas State J. Med. **32**:482, 1936.

3. Fienberg, Q.: Talcum Powder Granuloma, Arch. Path. **24**:36 (July) 1937.

4. German, W.: Dusting Powder Granulomas Following Surgery, Surg., Gynec. & Obst. **76**:501, 1943.

5. de Savitsch, E.: Granuloma Resulting from Penetration of Talcum Powder, M. Ann. District of Columbia **9**:169, 1940.

6. Byron, F. X., and Welch, C. S.: Complication from Use of Glove Powder, Surgery **10**:766, 1941.

7. McCormick, E. J., and Ramsey, T. L.: Postoperative Peritoneal Granulomatous Inflammation Caused by Magnesium Silicate, J. A. M. A. **116**:817 (March 1) 1941.

8. Ramsey, T. L.: Magnesium Silicate Granuloma, Am. J. Clin. Path. **12**:553, 1942.

9. Seelig, M. G.; Verda, D. J., and Kidd, F. H.: The Talcum Powder Problem in Surgery, J. A. M. A. **123**:950 (Dec. 11) 1943.

10. Lichtman, A. L.; McDonald, J. R.; Dixon, C. F., and Mann, F. C.: Talcum Granulomas, Surg., Gynec. & Obst. **83**:531, 1946.

11. Eiseman, B.; Seelig, M. G., and Womack, N.: Talcum Powder Granuloma: A Frequent and Serious Post Operative Complication, Ann. Surg. **126**:820, 1947.

12. Roberts, G. B. S.: Granuloma of the Fallopian Tube Due to Surgical Glove Talcum, Brit. J. Surg. **34**:417, 1947.

13. Klemm, C.: Foreign Body Granulomatosis of Peritoneum Caused by Talcum Powder, abstracted Helvet. chir. acta **14**:181, 1947.

physician the mass had been expanding in size during the preceding few weeks of observation, and therefore her statement about its short duration was probably correct. There was no tenderness; the surface of the mass was nodular, its consistency firm and its delineation from the surrounding subcutaneous tissue definite. The base of the tumor was broadly attached to the aponeurosis of the external oblique muscle. There was no fever, but the white blood cell count was increased to 12,000.

With the differential diagnosis of granuloma or sarcoma, the mass was excised with a small ellipse of skin, the appendectomy scar forming its axis. Since the gross examination of the tissue suggested sarcoma rather than inflammation, the incision was enlarged and a generous block excision was done including the adjacent subcutaneous fat and the tumor base consisting of the external oblique aponeurosis. The exposed portions of rectus and oblique abdominal musculature appeared uninvaded. Closure of skin could be accomplished by flexing the thigh. The subcutaneous space was drained through a stab wound and a compressing hip spica bandage applied. The postoperative course was uneventful. The abdominal wall appeared firm for some time in spite of the loss of fascia. However, four years after the operation a slight incisional hernia had established itself.

The specimen contained a uniformly hard induration diffusely originating from the aponeurotic layer but distinctly outlined against the subcutis, into which it projected with nodular prominences. The configuration and consistency of the tumor suggested sarcoma.

The microscopic sections revealed that the mass was composed of closely spaced small tubercles, the smallest about the size of a kidney glomerulus and others four to ten times larger. There were usually only slender strands of cellular connective tissue delineating the well rounded tubercles. The tubercle-like accumulations of cells extended diffusely into the dense sheet of connective tissue representing the removed piece of aponeurosis and in a like manner into the subcutaneous fat, but in this layer there was, at times, by way of encapsulation, a thin barrier of connective tissue laid down between the most peripheral tubercles and the fatty tissue. Throughout the mass and the adjacent adipose tissue, fair-sized blood vessels were noticeable with patent lumens and barely any inflammatory reaction in their walls.

The individual tubercles were composed predominantly of epithelioid cells which showed no inclination toward caseous necrosis. Round cells or lymphocytes were scarce and leukocytes absent. Many of the epithelioid cells were fused to form multinucleated giant cells with preserved tinctorial behavior, while other giant cells exhibited deeper-staining cytoplasma and nucleoplasma and therefore could be of a different origin. Significantly, small needle-like inclusions were found in many of the dark-staining giant cells. This finding, together with the fact that caseation was absent, led to the conclusion that a foreign body granuloma was being dealt with.

My colleagues and I were at first at a loss to determine the exact nature of the foreign body reaction until, stimulated by the publications of the group of workers at the Barnard Free Skin and Cancer Hospital, we studied our sections with a polarizing microscope. It immediately became clear that we were dealing with a foreign body reaction due to talcum. Subsequently, Dr. Werner, of the Department of Geology, Washington University, examined the section with special equipment and came to the conclusion that the crystalline foreign bodies found disseminated throughout the section and particularly contained within the giant cells were optically anisotropic with parallel extinction. "They looked and behaved like crystals of actinolite-tremolite, which is calcium magnesium silicate and frequently found in talcum powder as 'impurities.'"

COMMENT

The implantation of infinitesimal quantities of talcum into or onto human and animal tissue has been found to provoke inflammatory reactions varying greatly in intensity and persistency. It is obscure what factors are responsible for this variability of the tissue response, which is in contrast to the rather stereotyped histologic finding, namely, foreign body giant cells containing microcrystals singly or grouped in small clusters. When the tissue sections are viewed with polarized light the foreign substance can be identified with some facility; "the silicate crystals will be seen to stand out in brilliant illuminations as an electric sign in a night sky" (German). One has to defer, however, to expert petrographic analysis of the crystals in order to ascertain their chemical nature. One should also be aware of the fact that cellulose fibers are similarly refractile to polarized light.

The clinical pathologic pictures produced by talcum do not lend themselves easily to a general description. I propose therefore to recapitulate briefly what is generally known about the consequences of talcum irritations under five headings, a nosologic division which is admittedly arbitrary.

1. *Insemination of Talcum Without Apparent Tissue Reaction.*—Probably an appreciable number of contacts between talc and living tissue remain uncomplicated by visible clinical reaction. Since tissues are rarely examined histologically unless some gross changes arrest the attention, little is known about the prevalence or relative absence of microscopic tissue responses. From the observations reported in the following paragraph it seems likely that absolute inertia of the tissue defense against talc probably never prevails.

2. *Reactions of the Peritoneal Cavity to Talcum.*—Experiments on a smaller scale have been conducted by German [4] and mass experiments by Schultz and Williams,[14] Miller and Sayres [15] and Owen.[2] Almost regularly, the instillations of weak suspensions of talcum in isotonic sodium chloride solution or the sparse dusting of the visceral peritoneum with the dry powder would produce visible reactions. It remains, naturally, impossible to ascertain whether each and every point of contact between the mineral and the peritoneum became the site of a tissue reaction. The cumulative result of the experiments seems to be that talcum particles produce a visible nodule, which microscopically is represented by a focus of cellular accumulation in the serosa and subserosa engulfing the crystals. Macrophages and foreign body giant cells were found to contain the microcrystals intra-

14. Schultz, R. Z., and Williams, C. R.: Commercial Talcum: Animal and Mineralogic Studies, J. Indust. Hyg. & Toxicol. **24**:75, 1942.

15. Miller, J. W., and Sayres, R. R.: The Physiological Response of Peritoneal Tissue to Certain Industrial and Pure Mineral Dusts, Pub. Health Rep. **51**:1677, 1936.

cellularly. True granuloma formation, i. e., a clustering of such foci or the formation of adhesions, was not noted. As a matter of fact, German [4] emphasized the neat restoration of the serosal surface at the portal of entry of talcum into the peritoneum. Concerning the persistence of these talc nodules, long range experiments extending observations over a period of two years after exposure indicate a tendency toward a rather complete resolution of the cellular accumulations. In no instance was a progressive disease process found, which is of interest in connection with the case report given previously.

In the realm of human pathology the role of talcum as a provoker of significant pathologic changes in the peritoneal cavity cannot be doubted any more. Two types of peritoneal reactions have been ascribed to it: (*a*) nodular reaction grossly simulating tuberculosis or carcinomatosis and (*b*) adhesive peritonitis. Concerning the former, it may be stated with certainty that the etiologic role of the mineral is exclusive, since the findings conform with experimental observations. The dry, adhesive peritonitis type of reaction, on the other hand, is more difficult to evaluate. Since it is probable that similar peritonitic reactions have occurred without talcum, the etiologic role of this foreign body can be only suspected and may be merely a contributory one in persons who have this type of excessive peritoneal response. The absence of progressive adhesive inflammation of the peritoneum in the numerous experiments on animals cannot be overlooked, and it is questionable whether Bethune's production of adhesive pleuritis with talcum poudrage can be adduced in confirmation since he used massive quantities for his procedure.

Regardless of whether talc plays an exclusive or an auxiliary role in the production of postoperative adhesions in a given case, due consideration must be given this potentiality not only in the pathologic diagnosis but also in prophylaxis. German and, especially, Seelig and his co-workers [16] have emphasized this aspect, and the latter have justly called for the banishment of talcum from the operating room and the substitution of tartrate powder and later of special starches sufficiently heat resistant for use in the autoclave.[17]

3. *Injections of Talcum into Ocular Tissues.*—Irrigations of the anterior chamber of the eyes of small experimental animals and the injection into the sclera of talcum suspensions were done by Chamlin.[18]

16. Seelig, M. G.: Dangers of Talcum in the Peritoneal Cavity, J. A. M. A. **121**:1304 (April 17) 1943; Dusting Powder for Rubber Gloves, ibid. **123**:113 (Sept. 11) 1943; Dusting Powder for Surgical Gloves, ibid. **125**:1208 (Aug. 26) 1944.

17. Lee and Lehman, too, have recently reported that a certain modified starch could be used not only as a convenient but also as a safer glove powder (Surg., Gynec. & Obst. **84**:689, 1947).

18. Chamlin, M.: Effect of Talc in Ocular Surgery, Arch. Ophth. **34**:369 (Nov.-Dec.) 1945.

In the majority of eyes so treated inflammatory reactions featuring foreign body giant cells developed. On the basis of these results, Chamlin advocates the careful rinsing of the rubber gloves in a stream of sterile water. Seelig [19] has told me that a few milligrams of talcum injected by him into the anterior chamber of a rabbit's eyes sets up a violent reaction that leads to loss of sight.

4. *Talcum Granulomas in Connection with Foci of Suppuration.*—A histologic study of suppurating postoperative wounds and sinuses which makes use of the technic of polarized light will uncover in some the presence of talcum crystals within foreign body giant cells. Such foci of talc reaction with fistulous connection to the outside have been found in parenchymatous organs, in muscles and in the subcutis. For the purpose of emphasis there is selected from the several cases reported in the literature one of German's [4] in which talc granulomas developed in a circumcision wound. A cicatricial phimosis resulted and necessitated a second circumcision. The combination of chronic suppuration and talcum reaction appears as a typical disease process, easily acceptable as a parallel of tissue reactions to other foreign substances. The combination of the two factors, infection and foreign body, makes it impossible to decide which of them plays the leading role. It is possible that the incidence of infection gave rise to the inflammatory reactions, which subsequently focused also around the primarily inert mineral particles. Equally plausible is it to assume that the mineral material irritated the tissues to the extent that they were unable to cope with the contaminating bacteria and promoted the "taking" or the chronicity of the infection.

5. *The Sarcoid Talcum Reactions.*—Although the term sarcoid has been applied by prior observers, apologies are here offered for its lack of scientific distinctiveness. In consulting medical dictionaries, one learns that this expression does not impart a definte etiologic or histogenetic meaning. It seems that the term "sarcoid" was originally used to describe the pathologic tissues which grossly resembled sarcomas. Some, or most, of such sarcoid tumefactions were found microscopically to be conglomerations of tubercle-like inflammatory foci. At the present time only the diseases named after Boeck and Darier and Roussy, which resemble sarcoma in scarcely any respect but which have a histologic pattern of giant cell tubercles, are officially termed "sarcoid." The latter application is the only recognized modern use of the term sarcoid. In its original descriptive meaning it is no longer found in the nomenclature of diseases. This is somewhat regrettable since the granulomas provoked by talcum trisilicate sometimes assume a gross appearance simulating a sarcomatous new growth. Microscopically, they are indeed classic examples of giant cell tubercles forming large conglomerations. It is therefore both from the gross

19. Seelig, M. G.: Personal communication to the author.

and the microscopic observations that license is taken to call these specific forms of talcum reactions "sarcoids."

In contrast to all observations pertaining to pathologic changes in general produced by talcum experimentally, the talcum sarcoid observed clinically has a lag period, frequently covering years, and when once started may exhibit progressive tendencies which vie with those of infections.

Case reports which exemplify these sarcoid reactions are described by various authors. In Fienberg's [3] case a tumor developed in the fascia of abdominal muscles six years after an appendectomy. Byron and Welch [6] described a tumor measuring 2.5 by 4 cm. which developed in a laparotomy scar five years after a hysterectomy. Lichtman and others [10] mentioned in their extensive review a "sarcoid" of the gallbladder found eleven years after cholecystostomy, the talcum being presumably introduced by the drainage tube. German [20] described as "lupoid-sarcoid reaction" a nodule 2 cm. in diameter developing after fifteen years in a scalp wound which originally had healed by primary intention. Crystals of silica were found engulfed by foreign body giant cells. (In this case, however, the agent was not talc.)

Evidently these exquisitely tumefacient talcum reactions are much rarer than peritoneal talcum nodules or adhesions or talcum foci in a sinus after operation. This infrequency with which the cause (insemination of talc) produces the effect (sarcoid) suggests that the relationship is not a simple one and of necessity involves several unknown factors. As far as I am aware, no attempt has been made to elucidate them. At present any explanation would be only speculative and could at best merely outline possible approaches to the problem.

In making allowance for the great time lag in the development of these sarcoid reactions, one may be tempted to liken them to the fibrosis produced by silica, a related compound, in pulmonary tissue. This noxa is notorious for the delay of pathologic changes. This has been tentatively explained as due to a slow leaching of the silica by reagents produced secondarily in the tissues, new silica compounds thus formed going eventually into solution and irritating the tissues and eliciting a productive type of inflammation. Cases in which pulmonary fibrosis does not supervene evidently exemplify the innocuousness of chemically unaltered silica. A similar mechanism could be assumed operative in cases of talcum sarcoid with the implication that the solvents for the various silicates contained in industrial talcum powders are produced in the human body much less frequently than those leaching silica.

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20. German, W.: Lupoid-Sarcoid Reaction Induced by Foreign Body (Silica), Am. J. Clin. Path. **10**:245, 1940.

However, this is not the only hypothesis suggesting itself. One may propose that the mineral dust deposits in the tissues be considered as a localizing agent for an infectious noxa which, while gaining access to the focus on a subsequent occasion, acts as the real and immediate pathogen. In the field of experimental bacteriology it is a well known phenomenon that a general infection can be made to localize in areas predetermined by the injection of a foreign substance like kieselguhr.

If this theory should appear unattractive, reference may be made to some now almost forgotten sequelae of foreign body implantation. When silk sutures of heavier grades were more commonly used, progressive inflammatory tumors were known to develop in some instances many years after operation, especially after herniotomies (so-called Schloffer tumors [21]). The nucleus of these swellings was usually a minute abscess around a silk thread. In a similar manner, i. e., after long lag periods, huge swellings of the omentum (described by Braun) have developed after its partial resection with the aid of silk sutures. In order to perturb any one who might contend that this omentitis of Braun is simply a protracted surgical bacterial contamination with late rekindled inflammation, Probstein [22] reported a case of extensive omentitis in which no laparotomy or trauma preceded the infection.

Accordingly, the logical possibilities to explain the talcum sarcoid and especially its conspicuous lag period narrow down to three, with a free choice between them: 1. In some, but only comparatively few, patients "antibodies" to one of the silicates contained in industrial talcum eventually develop. The interaction between the talcum and the antigen elicits a tissue response in the form of giant cell tubercles. 2. The minute mineral deposits of talcum act as "localizers" for certain unknown bacterial or viral organisms circulating otherwise harmlessly in the body. 3. The mineral deposits prevent the elimination of bacterial or viral contaminations incident to the surgical exposure. Clinically perceptible inflammations develop when the dormant organisms become virulent.

SUMMARY

The nefarious potentialities of talcum glove powder have only recently been recognized. One of the rarer postoperative complications attributable to minute quantities of this material is the development of a sizable hard tumor-like swelling as late as ten years or more after the surgical intervention.

The long latency period and the size of this "sarcoid" foreign body reaction distinguish it from other, more common, talcum reactions.

21. Roska, L.: Schloffer Tumor of the Abdominal Wall, Zentralbl. f. Chir. **66**:1757, 1939. Schloffer, H.: Ueber chronisch entzuendliche Bauchdecken-geschwuelste nach Bauch-operationen, Verhandl. d. deutsch. Gesellsch. f. Chir. **37**: 229, 1908.

22. Probstein, J. G.: Recurrent Omental Hypertrophy, Am. J. Surg. **16**:50, 1932.

PSEUDOCYST OF THE LIVER

Report of a Case

EDGAR J. POTH, M.D., Ph.D.
AND
A. WILLIAM DeLOACH, M.D.
GALVESTON, TEXAS

POST-TRAUMATIC bile cysts of the liver are extremely rare. A search of the literature reveals only 4 cases which have been recorded.[1] The nonparasitic bile cyst could properly be classified as a pseudocyst by comparing it with the pseudocyst of the pancreas, which does not have an epithelial lining. Nonparasitic cysts of the liver, which are not the direct result of trauma, are not so rare. Davis [2] reviewed the literature on nonparasitic cysts in 1937 and gathered 499 cases, of which 241 were classified as cases of cystic disease of the liver with multiple cysts, 187 as cases of solitary unilocular cysts and 20 as cases of solitary and monolocular cysts. The remaining 51 were not classified. Clagett and Hawkins [3] have recently reported the successful removal of a multilocular cyst by extirpation of the entire left lobe of the liver.

REPORT OF A CASE

A white girl aged 3 was first seen in the John Sealy Hospital on Sept. 5, 1947, at 10 a. m. She had just been run down by an automobile. Whether or not the vehicle passed over the child's body could not be determined. Examination revealed a child in a moderate degree of shock; there were swelling and edema of the left side of the face. Some rales could be heard at the right base. There was no dulness. Abdominal tenderness and rigidity were generalized, but they were more pronounced on the right side. There was a small tear in the perineum. There was roentgenologic evidence of increased bronchovascular markings in

From the Surgical Research Laboratory and the Department of Surgery, University of Texas, Medical Branch.

1. Curran, J. F., and Goodale, R. H.: Traumatic Bile Cyst of Liver, New England J. Med. **207**:1192, 1932. Whipple, C.: A Case of Traumatic Rupture of the Liver: Formation of Cystic Swelling Containing Bile-Stained Fluid; Incision and Drainage; Recovery, Lancet **1**:719, 1898. Aldridge, A. R.: Rupture of the Liver: Formation of Cystic Swelling Containing Bile-Stained Fluid, ibid. **1**:1616, 1898. McQuillan, A. H.: Traumatic Bile Cyst, J. Maine M. A. **19**:193, 1928.

2. Davis, C. R.: Non-Parasitic Cyst of the Liver, Am. J. Surg. **35**:590, 1947.

3. Clagett, O. T., and Hawkins, W. J.: Cystic Disease of the Liver, Ann Surg. **123**:111, 1946.

both lungs. In the right lung there were mottled shadows of increased density which were suggestive of alveolar hemorrhage or possibly bronchopneumonia. There was an incomplete linear fracture of the right wing of the ilium. The temperature was 101 F., the pulse rate 140, the respiratory rate 40 and the blood pressure 80 systolic and 40 diastolic. The child responded rapidly to expectant treatment. She was afebrile on the fourth day of hospitalization and was dismissed on the eleventh day. The following day the patient was returned to the hospital because of swelling of the abdomen. At this time she had a temperature of 100.2 F. The abdomen was distended and tender. She ate poorly. There was no evidence of obstruction of the gastrointestinal tract, and she had not vomited. The abdominal tenderness was still primarily on the right side. The condition slowly resolved itself, and the patient was dismissed from the hospital five days later. Four days later she vomited and was readmitted to the hospital. Abdominal distention had continued. She had a temperature of 101 F., a pulse rate of 120 and a blood pressure of 90 systolic and 60 diastolic. She was eating well and had received daily enemas. The abdomen was protuberant, with tenderness to palpation in both upper quadrants. There was moderate muscle spasm over the entire abdomen. Intra-abdominal viscera could not be felt. On the sixth day of this stay in the hospital the abdomen became distended, and for the first time a large epigastric mass about 8 cm. in diameter was palpable. This mass was dull to percussion. The nonprotein nitrogen was 22 mg. per hundred cubic centimeters, the serum amylase 60 units and the reaction to the cephalin flocculation test 2 plus in 24 and 48 hours. The blood count showed 3,850,000 red cells and 16,400 leukocytes, with a differential count of 61 per cent polymorphonuclear cells, of which 52 per cent were adult forms, 36 per cent lymphocytes, 2 per cent monocytes and 1 per cent basophils. The sedimentation rate was 42 mm. in 1 hour. Repeated determinations of the serum amylase level showed 57 units. Four days later roentgenologic examination revealed the stomach to be pushed to the left and downward. A tentative diagnosis of pseudocyst of the pancreas was made. Intravenous urographic examination showed the kidneys to be normal.

On the following day the patient was examined through a short, transverse incision above the umbilicus and to the left. A cystic mass presented itself in the wound, from which clear bile could be aspirated. The cyst was about 10 cm. in diameter and occupied the anterior surface of the left lobe of the liver. It contained approximately 150 cc. of clear bile and was just beneath the capsule of the liver. It was excised. The cyst wall was easily stripped from the surface of the liver. At one point on the surface of the liver there was an opening about 2 mm. in diameter from which clear bile issued. This opening was closed with a purse string suture of 2-0 chromic surgical gut. Exploration revealed no other abnormalities of the intra-abdominal contents, and the abdomen was closed without drainage. For about ten days postoperatively there was abdominal distention, with some vomiting. Thereafter the course was uneventful, and the patient was dismissed from the hospital on the twentieth postoperative day and has continued to be well. Microscopically, the inner surface of the cyst wall was composed of dense fibrous connective tissue. There was no true epithelial lining. In the outer layers of the wall the tissue was loose and edematous and contained numerous engorged blood vessels. There was abundant collagen formation. The essential features were those of marked connective tissue hyperplasia.

COMMENT

The development of the traumatic bile cyst does not follow any clear pattern, and there is not a definite train of signs or symptoms. There is abdominal distention, with tenderness. The appetite may be poor. There is prostration, with occasional low grade fever. Sometimes vomiting of mild degree occurs and finally localization of tenderness over the cystic mass. In the reported cases the mass had developed within one to five weeks. In this case it was first palpable one month after the injury. In no instance was a correct diagnosis made preoperatively. In all probability, traumatic bile cysts of the liver should be considered as primary lesions and be defined as a pseudocyst of the liver similar to the pseudocyst of the pancreas. It is conceivable that a pseudocyst of the liver could arise after the resolution of a deep abscess in the liver under the influence of chemotherapy and antibiotic treatment or after the resolution of a large intrahepatic hematoma.

SUMMARY

The fifth case of nonparasitic cyst of the liver following trauma is presented, and it is proposed that these bile cysts be known as pseudocysts of the liver. The maximum postoperative rectal temperature was 101 F. It returned to normal on the second postoperative day and remained normal throughout the patient's stay in the hospital.

ISLET CELL TUMOR OF THE PANCREAS

FREDERICK H. AMENDOLA, M.D.
NEW YORK

THE PATIENT whose history is reported in this communication presented a tumor of islet tissue which was of interest for the following reasons: It did not produce hyperinsulinism; it was unusually large in size, and it had undergone cystic degeneration, which is rare in growths of this type.

REPORT OF A CASE

History.—On May 12, 1942, a 65 year old housewife was admitted to the Roosevelt Hospital complaining of pain in the left upper region of the abdomen. Except for a hysterectomy for uterine fibroids twenty years previously, there had been no medical or surgical illnesses of any significance. In April 1942, about four weeks prior to her admission, the patient began to have a constant dull ache in the epigastrium and left upper quadrant. Within a few days she began to have occasional vomiting, which soon became persistent. During the ensuing three weeks she had retained no solid food whatever, and for several days prior to her admission she had been vomiting liquid feedings as well. The stools and urine had been scanty but normal in color. She had had no chills or fever. The pain had gradually become more severe and seemed to have become definitely localized in the left upper quadrant and left subcostal area.

Physical Examination.—Examination revealed an obese elderly white woman 65 years of age, weighing 168 pounds (76.2 Kg.), who was acutely ill. The temperature was 99 F., the pulse rate 68 and the respiratory rate 20. The blood pressure was 130 systolic and 70 diastolic. The scleras were not discolored. The tongue was thick and dry. There were no palpable cervical or supraclavicular nodes. The lungs were clear. The heart was slightly enlarged to the left, and the sounds were of good quality, with no murmurs. The abdomen showed a well healed median suprapubic scar. In the left upper quadrant there was a smooth round mass about 12 cm. in diameter, which was slightly tender and which appeared to be fixed. It did not move with respiration. The liver and spleen were not palpable. The extremities were normal.

Clinical and Laboratory Studies.—The urine and blood were entirely normal. Intravenous pyelograms showed good filling of the pelves and calices, with no evidence of dilatation or pressure defect. Both ureters were well outlined and showed no displacement.

After four days of observation and preparation, including blood transfusions and infusions of dextrose and isotonic sodium chloride solution, the patient was operated on, on May 16, 1942. The preoperative diagnosis was tumor of the pancreas.

From the Surgical Service of the Roosevelt Hospital.

Operation.—A subcostal incision, with division of the left rectus and oblique muscles, was made on the left side. The gastrocolic omentum was divided and the mass exposed. It proved to be a somewhat purplish, cystic tumor about 14 cm. in diameter springing from the tail of the pancreas. After incision of the peritoneal covering, the tumor was freed down to the point of its attachment to the pancreas. The splenic vessels were isolated and retracted after division and ligation of their pancreatic branches. The tail of the pancreas was divided between clamps, and a segment 8 cm. long was removed with the attached tumor. The pancreatic stump was closed with interrupted sutures of black silk. Careful palpation of the head of the pancreas failed to reveal any nodules. The gastrocolic omentum was reconstructed. The wound was closed in layers without drainage. The time for the operation was one hour thirty-five minutes. The procedure was well borne.

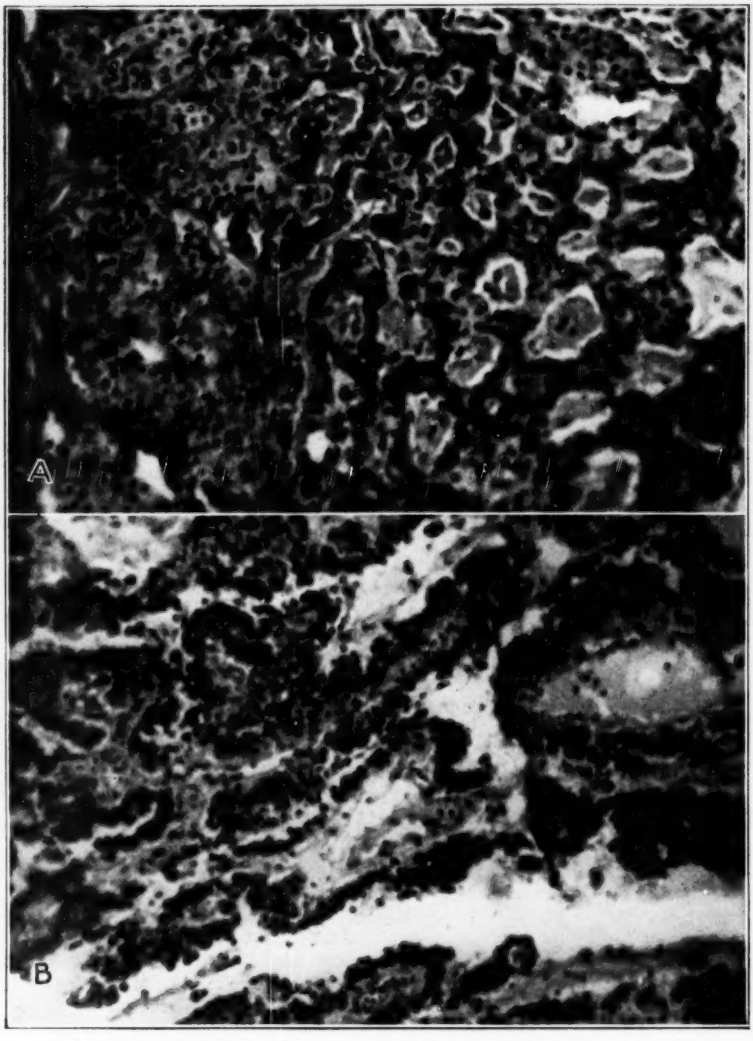
Pathologist's Report.—The specimen measures 12 by 15 cm. in its diameter. Its surface is smooth except at the point of attachment to a mass of finely lobulated tissue which appears to be pancreas and which measures 8 by 3.6 cm. The tumor contains 450 cc. of bloody fluid in which there are large masses of apparently necrotic, friable, grayish yellow material. The cyst wall measures up to 1 cm. in thickness and is composed of soft reddish gray tissue. The lining is gray and smooth except in areas to which necrotic fragments are adherent. There is a line of cleavage between the pancreatic tissue and the cystic mass.

Microscopic Examination (figure 8).—The finely lobulated structure is the pancreas. The alveoli are not unusual, but there is some fat infiltration in the stroma. There are abundant, apparently normal islets of Langerhans. The interlobular arterioles are slightly thickened, and there is some increase in perivascular fibrous tissue. In one section of the wall of the cyst there is a wide zone of fibrous tissue. On the inner surface of this tissue there is pink-stained material which is amorphous except for slits in its substance which suggest the presence of cholesterol or fatty acids.

Within the fibrous tissue there are numerous large islands of epithelial cells. In this section there is some suggestion of papillary forms, but it is more characteristic for the cells to occur as solid, irregularly shaped sheets. The cells are small but uniform in size. They have a finely granular, pale pink cytoplasm and round or oval nuclei with moderate quantities of chromatin which is uniformly distributed throughout the nuclei in coarse granules. In other areas there is less fibrous tissue and there are more definite papillary forms. In general, however, the epithelial cells are arranged in elongated epithelial sheets. The individual cells in these areas are similar to those described. There are occasional large, hyperchromatic nuclei. Some islands of epithelium are present in vascular spaces.

Diagnosis.—The diagnosis was islet cell tumor of the pancreas. The slides were submitted to Dr. Virginia Kneeland Frantz and Dr. Arthur Purdy Stout. It was their opinion that we were dealing with an islet cell tumor despite the unusual gross features of the specimen. All except a single reported islet cell tumor have been solid structures. Dr. Frantz also pointed out that the criteria of malignancy in these growths are not well defined and that the epithelial tissue in the vessels did not establish the growth as malignant.

Course.—The patient made a smooth, uneventful recovery and was discharged from the hospital on the seventeenth postoperative day. Her wound was well healed, and she was entirely free of symptoms. On Oct. 7, 1946, four years and five months after operation, she was readmitted to the Roosevelt Hospital and an emergency operation was performed for acute perforation of a gastric ulcer.

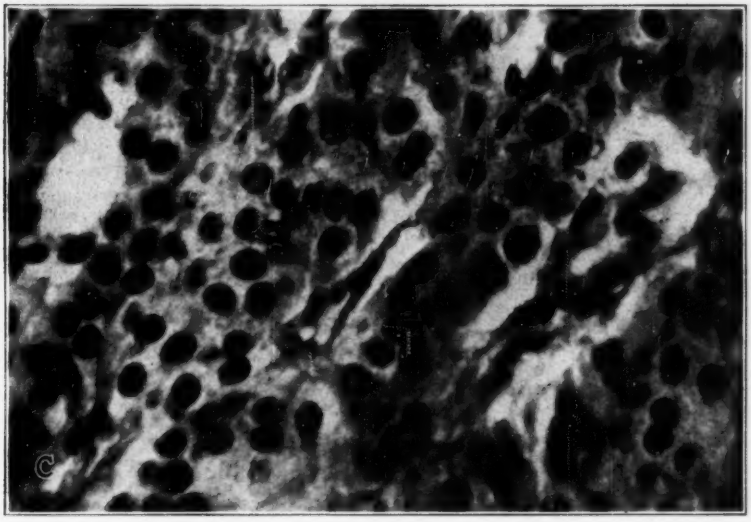


Islet cell tumor of pancreas. *A*, section through subcapsular area. Low power magnification; hematoxylin and eosin. *B*, section through inner portion of tumor. Low power magnification; hematoxylin and eosin.

A simple closure of the perforation was performed after excision of tissue from its edges for microscopic examination. Exploration of the abdomen revealed no evidence of recurrence of the tumor removed in May 1942. The patient had a smooth convalescence and when last examined was feeling well.

COMMENT

Numerous theories on the origin of islet cell tumors have been proposed. It may be said that, in general, there have been three basic concepts: 1. The tumors arise from embryonal rests. 2. The tumors arise from preexisting mature islands. 3. The tumors arise from the excretory ducts of the pancreas. Histologic and embryologic investi-



C, high power magnification showing sheets of islet cells with deeply-staining uniform round nuclei.

gations [1] have indicated that the epithelial cells of the islets are derived from the epithelium lining the small excretory ducts of the pancreas. It has long been known that after ligation of the pancreatic ducts the islet tissue persisted and the acinear cells atrophied. In the process of regeneration of the pancreas following temporary ligation, it has been demonstrated [2] that duct epithelium gives rise to both islet and acinar

1. Bensley, R. R.: Studies on the Pancreas of the Guinea Pig, Am. J. Anat. **12**:297, 1911. O'Leary, J. L., and Womack, N. A.: Histology of Adenoma of Islets of Langerhans, Arch. Path. **17**:291 (March) 1934.

2. Grauer, T. P.: Regeneration in the Pancreas of the Rabbit, Am. J. Anat. **38**:233, 1926.

tissue. In a recent publication, Good [3] has shown, on the basis of careful histologic investigation, that the structure of the wall of the pancreatic duct and that of the wall of the capsule of an islet tumor is the same and that, in fact, the capsule is the duct wall. He further believes that the presence or absence of a capsule depends on whether the tumor took origin in a duct with or without a wall.

The number of reported cases of islet cell tumor without hypoglycemia, exclusive of those found incidentally at autopsy, is small.[4] This is readily understandable since, in the absence of clinical symptoms of hypoglycemia, these tumors would be removed in all probability only if they should grow large enough to be discovered by abdominal palpation or in the event of massive malignant degeneration or perhaps unexpectedly in the course of abdominal exploration.

It is difficult to explain why certain islet cell tumors produce hypoglycemia while others do not. It is also difficult to understand why a large tumor such as that reported by Brunschwig,[5] measuring over 10 cm. in diameter, should not produce a more severe clinical picture than the average tumor measuring only 1 or 2 cm. in diameter. The cells of an inactive tumor, i. e., one not producing hypoglycemic symptoms, may be filled with the typical granules characteristic of the tumor which produces hyperinsulinism.[6]

In approximately 15 per cent of the reported cases more than one tumor was found at operation. While in most instances multiple tumors will be found within a few centimeters of each other in the tail or body of the pancreas, the frequent finding of a solitary or second tumor in the head of the organ makes thorough palpation of the entire organ imperative. However, many recorded cases indicate that even the most careful palpation may be deceptive and one or more small tumors may be overlooked.[4a]

SUMMARY

A report is made of an unusually large islet cell tumor of the pancreas which showed a rare cystic degeneration and did not produce hypoglycemic symptoms.

3. Good, L. P.: Origin and Growth of an Adenoma of the Islands of Langerhans, Surgery **18**:159, 1945.

4. (*a*) Frantz, V. K.: Adenomatosis of Islet Cells, with Hyperinsulinism, Ann. Surg. **119**:824, 1944. (*b*) Sailer, S., and Zinninger, M. M.: Massive Islet Cell Tumor of the Pancreas Without Hypoglycemia, Surg., Gynec. & Obst. **82**:301, 1946.

5. Brunschwig, A.: Large Islet Cell Tumor of the Pancreas, Surgery **9**:554, 1941.

6. Whipple, A. O.: Pancreaticoduodenectomy for Islet Carcinoma, Ann. Surg. **121**:847, 1945.

GRANULOMAS OF THE ILEOCECAL REGION SECONDARY TO APPENDICITIS (LIGNEOUS CECITIS) WHICH SIMULATE NEOPLASMS

JAMES W. WILSON, M.D.
MALCOLM B. DOCKERTY, M.D.
JOHN M. WAUGH, M.D.
AND
J. ARNOLD BARGEN, M.D.
ROCHESTER, MINN.

THIS STUDY was prompted by the occasional observation of specimens of the right part of the colon in cases of lesions which had been surgically diagnosed as carcinoma of the cecum and which, on pathologic examination, turned out to be merely inflammatory reactions about a diseased appendix. It was our objective to try to establish more exact methods of recognizing this condition so that a less radical operation might be done. In this regard, it was deemed necessary to investigate, as well, cases in which only appendectomy was done, to determine whether this operation alone could bring about cure in the face of the extensive inflammatory reaction about the offending appendix.

REVIEW OF THE LITERATURE

These lesions have been described under a number of titles in the literature. Prior to the classic paper on appendicitis by Fitz,[1] every kind of inflammatory lesion of the right side of the abdomen and pelvis was included under the term "typhlo-enteritis." After that time there arose a controversy as to whether any such entity as primary typhlitis existed or whether all forms of typhlitis originated in the

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Abridgment of thesis submitted by Dr. J. S. Wilson to the faculty of the Graduate School of the University of Minnesota in partial fulfilment of the requirements for the degree of Master of Science in Surgery.

Dr. Wilson is a fellow in surgery at the Mayo Foundation, Dr. Dockerty is from the Section on Surgical Pathology, Dr. Waugh is from the Division of Surgery and Dr. Bargen is from the Division of Medicine, Mayo Clinic.

1. Fitz, R. H.: Perforating Inflammation of the Vermiform Appendix, With Special Reference to Its Early Diagnosis and Treatment, Boston M. & S. J. **115**: 13 (July 8) 1886.

appendix.[2] Concurrently with the development just described, a good deal of interest was shown in nonspecific granulomatous lesions in the abdomen which were mistaken for neoplasms.[3]

W. J. Mayo [4] was the first surgeon to make a definite reference to appendical inflammations which were indistinguishable from neoplastic disease. Bergmann [21] collected the largest series, namely, 15 reports of cases of cecal granulomas secondary to appendicitis.

Individual cases or small series have been reported under a variety of titles. Goto,[5] Läwen,[6] Ravdin and Rhoades [7] and Homans and

2. (*a*) Bernard, R., and Milone, S.: Typhlites aigues et chroniques et leurs rapports avec l'appendicite, Arch. d. mal. de l'app. digestif. **20**:1052-1069, 1930. (*b*) Biedermann, H.: Durch Darmresektion geheilte primäre Phlegmone des Dickdarms mit Inversion der Coecalwand, Beitr. z. klin. Chir. **124**: 718-722, 1921. (*c*) Brams, W. A., and Meyer, K. A.: A Study of Acute, Primary Typhlitis, J. A. M. A. **84**: 436-437 (Feb. 7) 1925. (*d*) Bryan, W. A.: Simple Inflammatory Lesions of the Cecum, Tr. South. S. A. **43**: 320-330, 1930. (*e*) Fiolle, J.; Luccioni, F., and Lluccia, H.: Les typhlites appendiculaires à retardement: Ictus cæcoux; Formes gangreneuses, formes abortives, J. de chir. **42**: 177-189 (Aug.) 1933. (*f*) Lazarus, J. A.: Primary Inflammatory Tumor of the Cecum Without Appendicitis, Am. J. Surg. **1**:350-356 (Dec.) 1926. (*g*) Nemilov, A.: Ueber entzundliche Dickdarmgeschwülste und ihre Bedeutung in der Pathologie des Blinddarms, Arch. f. klin. Chir. **153**: 346-357, 1928. ((*h*) Powers, J. H.: Unusual Inflammatory Lesions of the Ileocecal Region, Ann. Surg. **103**: 279-289 (Feb.) 1936. (*i*) Bergmann, V., cited by Läwen.[6]

3. (*a*) Bachlechner, K.: Ueber entzündliche Ileocolcaltumoren, Beitr. z. klin. Chir. **124**:103-115, 1921. (*b*) Bargen, J. A., and Jacobs, M. F.: Inflammatory Cecal Tumors: Diagnosis of Types of Obscure Etiology, Arch. Surg. **20**:832-850 (May) 1930. (*c*) Barnes, J. P.: Non-Specific Granuloma of the Colon, Texas State J. Med. **39**:529-532 (Feb.) 1944. (*d*) Braun, H.: Ueber entzündliche Geschwülste am Darm, Deutsche Ztschr. f. Chir. **100**:1-12, 1909. (*e*) Korte, W.: Ueber entzündliche Geschwülste am Darm, Arch. f. klin. Chir. **118**:138-163, 1921. (*f*) Mock, H. E.: Infective Granuloma: Non-Specific Chronic Tumor-Like Productive Inflammations of Gastro-Intestinal Tract, Surg., Gynec. & Obst. **52**:672-689 (March) 1931. (*g*) Moynihan, B. G. A.: The Mimicry of Malignant Disease in the Large Intestine, Edinburgh M. J. **21**:228-236 (Jan.) 1907. (*h*) Moschcowitz, E., and Wilensky, A. O.: Non-Specific Granulomata of the Intestine, Am. J. M. Sc. **166**:48-66, 1923. (*i*) Rankin, F. W.; Bargen, J. A., and Buie, L. A.: The Colon, Rectum, and Anus, Philadelphia, W. B. Saunders Company, 1932, p. 203. (*j*) Robson Mayo, A. W.: Some Abdominal Tumors Simulating Malignant Disease and Their Treatment, Brit. M. J. **1**:425-428 (Feb. 22) 1908. (*k*) Virchow, R., cited by Teitze.[17b]

4. Mayo, W. J.: Inflammations Involving the Caecum: Its Appendix or Both, Tr. Minnesota M. Soc., 1888, pp. 63-72.

5. Goto, S.: Ueber die einfache chronische entzündliche Strictur des Darmes, Arch. f. klin. Chir. **97**:190-206, 1912.

6. Läwen, A.: Ueber Appendicitis fibroplastica, Deutsche Ztschr. f. Chir. **129**:221-241, 1914.

7. Ravdin, I. S., and Rhoades, J. E.: Regional Ileitis and Fibroplastic Appendicitis, Ann. Surg. **106**:394-404 (Sept.) 1937.

Hass [8] wrote about fibroplastic appendicitis. Moschcowitz and Wilensky [2h] used the term "nonspecific granuloma," and Mock [2f] presented a great deal of pathologic substantiation for the use of the name "infectious granuloma." Kelly and Hurdon [9] wrote about circumscribed appendical abscesses, while Walters and Synhorst [10] and Caylor [11] used the term "ligneous inflammation of the cecum." Many of the cases in the aforementioned papers do not conform to the rigid criteria used in selecting the cases for this study.

Since the establishment of regional enteritis as an entity,[12] there has been some controversy as to whether appendical granulomas are not unusual manifestations of this disease.

INCIDENCE

These lesions are rare. Bachlechner [3a] collected reports of 41 cases but did not give a detailed summary of those he included. Bernard and Milone [2a] were able to add 20 cases, while Ravdin and Rhoades a few years later found reports of only 15 cases after the time of the appearance of Bachlechner's paper.

ETIOLOGY AND PATHOGENESIS

Perforation of the appendix as the initiating lesion in these tumors was noted by numerous authors.[13] In other cases the lesion was ascribed to prolonged, mild inflammation about appendical fecaliths and foreign bodies.[14] Prolonged low grade infection without obstructive features was incriminated by some writers and usually was associated with a large thickened appendix.[15] Two cases were reported

8. Homans, J., and Hass, G. M.: Regional Ileitis: A Clinical, Not a Pathological Entity, New England J. Med. **209**:1315-1324 (Dec. 28) 1933.

9. Kelly, H. A., and Hurdon, E.: The Vermiform Appendix and Its Diseases, Philadelphia, W. B. Saunders and Company, 1905, p. 321.

10. Walters, W., and Synhorst, A. P.: Ligneous Infection of the Cecum Resulting from Subacute Appendicitis, S. Clin. North America **6**:1203-1206 (Oct.) 1926.

11. Caylor, H. D.: Cecum lignum, J. Indiana M. A. **31**:62-65 (Feb.) 1938.

12. Barbosa, J. deC.; Bargen, J. A., and Dixon, C. F.: Regional Segmental Colitis, S. Clin. North America **25**:939-968 (Aug.) 1945. Crohn, B. B.; Ginzburg, L., and Oppenheimer, G. D.: Regional Enteritis: A Pathological and Clinical Entity, J. A. M. A. **99**:1323-1329 (Oct. 15) 1932.

13. Hartwell, J. A.: Non-Tuberculous Inflammation of the Cecum, S. Clin. North America **1**:361-365 (April) 1921. Okinckzyc, cited by Bernard and Milone.[2a] Rhoades, R. L.: Discussion, Tr. South. S. A. **43**:329-330, 1930. Bernard and Milone.[2a] Bachlechner.[3a] Korte.[3e] Walters and Synhorst.[10]

14. Bernard and Milone.[2a] Bachlechner.[3a] Läwen.[6] Korte.[3e] Kelly and Hurdon.[9]

15. (*a*) Gangitano, F.: Ueber periappendiculäre pseudo-neoplastische entzündliche Tumoren, Arch. f. klin. Chir. **89**:399-422, 1909. (*b*) Kolouch, F. G.: Non-Tuberculous Inflammation of the Cecum: Report of Case, Nebraska M. J. **8**:106-107 (March) 1923. (*c*) Bernard and Milone.[2a] (*d*) Bryan.[2d] (*e*) Bachlechner.[3a] (*f*) Ravdin and Rhoades.[7]

in which the lesion arose in the residual stump of an incompletely removed appendix.[16] Several authors[17] cited cases in which the lesion arose around nonabsorbable suture material used during appendectomy. Nemilov[2g] particularly expressed a belief that there was a real danger of intramural abscess formation when nonabsorbable material was used for both the appendical stump ligature and the purse-string suture since this procedure resulted in trapping infected mucosa between the suture lines.

Mock[3f] and Gangitano[15a] each reported a case in which trauma played a part in initiating granulomatous lesions.

Bernard and Milone were the only authors to point out that in the patients involved the appendix was frequently retrocecal and that the average age was over 40 years. They expressed the thought that this combination of an appendix with a lowered secretory function lying in an easily walled-off space accounted for the chronic, localized inflammatory reaction.

The extension of the inflammation to the ileum and cecum was explained on the basis of contiguity by most authors. Some of the French writers[18] expressed a belief that retrograde arterial thrombosis and thrombosis of the ileocecal veins were factors in the spread of the process. Mock expressed a belief that the underlying cause was a local interference with the blood supply. He postulated a vicious circle of inflammatory vascular occlusion, focal necrosis and reactive fibrosis which caused obliteration of more vessels and consequent slow progression of the necrotizing process. Läwen suggested that the fibrous overgrowth was due to a fibroplastic diathesis but offered no supportive evidence for this view.

PATHOLOGIC PROCESS

The gross picture as described in the literature was that of a fibrous mass sometimes containing small abscesses. As Mock pointed out, the tumor at times was the size of a grapefruit, irregular in outline, and included adjacent tissues within its boundaries. The consistency varied from hard induration to soft abscess cavities, and the neighboring lymph nodes were frequently enlarged.

Microscopically, the prominent feature was the marked increase in fibrous tissue, which varied from dense scar to young granulation tissue. Interspersed throughout this tissue were areas of round cell

16. Bernard and Milone.[2a] Nemilov.[2g]

17. (*a*) Routier, cited by Gangitano.[15a] (*b*) Tietze, A.: Ueber entzündliche Dickdarmgeschwülste, Ergebn. d. Chir. u. Orthop. **12**:211-273, 1920. (*c*) Mock.[3f]

18. Hovelacque, and Sourdin, cited by Bernard and Milone.[2a] Bernard and Milone.[2a] Fiolle, Luccioni and Lluccia.[2e]

infiltration, microscopic abscesses filled with polymorphonuclear leukocytes, areas of necrosis and scattered giant cells. Läwen and Mock noted the frequency of occurrence of occlusive thickening of the media of the arterioles.

DIAGNOSIS

As a rule the clinical diagnosis was carcinoma, though Bargen and Jacobs [3b] threw some light on the diagnosis of these lesions by pointing out that a sense of well-being, absence of anemia and lack of the typical roentgenologic [19] picture of carcinoma would help in distinguishing granulomatous from malignant lesions.

The surgical diagnosis was frequently faulty, and in 1 of Mock's cases even the employment of frozen sections did not result in the making of a correct diagnosis. The only aid suggested was a statement by Bernard and Milone that in cases of these lesions there is a line of cleavage behind the cecum which leads to the diseased appendix.

TREATMENT

In 4 cases appendectomy [20] and in 1 coring out of the appendical mucosa [10] resulted in cure. Ileocolostomy was successful in several instances, while in other cases [21] it failed and resection was necessary. Most of the tumors were resected as carcinoma. All patients who survived did well, but in some chronic sinuses developed, and a few patients died of peritonitis.

SELECTION OF CASES

In order to obtain the material for this study, the surgical files of the Mayo Clinic were searched for records bearing the diagnosis of "inflammatory lesion of the right side of the colon," "perityphlitis," "appendical or periappendical granuloma" and similar conditions. The period covered was the years 1905 to 1945 inclusive. Discarded were cases in which inadequate material was available for pathologic study. Also eliminated were all cases in which regional enteritis and segmental ulcerative colitis might be present. In the first place all case records were checked for later development of recurrence of symptoms or of clinical or roentgenologic evidence suggesting regional enteritis or colitis.[22] As a further safeguard, no case was included in which there was even microscopic evidence of ulceration of the mucosa of the ileum

19. Weber, H. M.: Non-Neoplastic Tumefactive Lesions of the Large Intestine: Inflammatory Tumefactions, Am. J. Roentgenol, **36**:637-647 (Nov.) 1936.

20. Caylor.[11] Gangitano.[15a]

21. Nemilov.[2g] Läwen.[6]

22. Hadfield, G.: The Primary Histological Lesion of Regional Ileitis, Lancet **2**:773-775 (Oct. 7) 1939. Bargen and Jacobs.[3b]

or colon. In addition, all specimens showing inflammatory changes in the wall of the ileum or colon beyond the immediate confines of the granuloma were rejected.

It was felt that the employment of these rigid criteria should adequately rule out regional enteritis in all cases in which hemicolectomy was done on the right side. In cases in which only the appendix was removed there could be some doubt. In the last-mentioned cases, however, there were definite serious pathologic changes in the appendixes, and the surgical notes on the records indicated that the ileum and colon were grossly normal.

In order to be sure that the lesions associated with appendical disease were typical granulomas, certain arbitrary rules were established. No cases were included in which a fistula or sinus persisted after drainage of an appendical abscess, as it was felt that the drainage could be held responsible for the excessive response of the fibrous tissue. Whenever a frank appendical abscess of moderate size was found, even though it was encapsulated and mistaken for carcinoma, the case was rejected. Furthermore, when the mass was resected and found to consist only of dense fibrous adhesions, the case was not included even though a previous ileocolostomy had been done which had resulted in considerable diminution of the size of the tumor. Such a response might well indicate resolution of a granulomatous process, but, since the assumption could not be proved, the cases were eliminated.

Needless to say, in none of the group used was there evidence clinically, surgically, pathologically, bacteriologically or on follow-up of syphilis, actinomycosis, tuberculosis, amebiasis or lymphogranuloma. In one instance the possibility of a healed ruptured diverticulum could not be excluded and the case was rejected.

METHODS OF STUDY

Pathologic material, available in all cases, had been preserved in 10 per cent solution of formaldehyde. This material was secured and studied in great detail. Sections were taken from the granulomatous mass, from the appendix if present and from the ileal and cecal walls and the lymph nodes. In some cases large mounted microscopic sections were made through the whole tumor to study its over-all structure.

REPORT OF ILLUSTRATIVE CASES

Twenty cases were used for study, and almost as many probable cases were excluded for the reasons mentioned previously. In all these the lesion was mistaken for a malignant one by either the clinician, the roentgenologist or the surgeon and sometimes by all three (table 1). Four of these cases will be reported in detail to illustrate some of the

TABLE 1.—*Summary of Diagnoses, Treatment and End Results*

Case	Diagnosis			Treatment	
	Clinical	Roentgenologic	Surgeon's	Type	End Result
1	Carcinoma 90 per cent; inflammatory 10 per cent; probably carcinoma	Filling defect of cecum; intrinsic or extrinsic	Inflammatory mass but might be carcinoma or actinomycosis	One stage resection	Well 6 yr. later
2	Diverticulitis (?) or appendicitis	Filling defect of the rgiht transverse and hepatic colon	Carcinoma	One stage resection	Died fifth postoperative day
3	Cecal tumor, probably malignant	Cecal deformity	First stage: carcinoma; second stage: stricture from abscess	Two stage resection	Well 13 yr. later
4	Cecal carcinoma, appendical nuscess (?)	Indeterminate lesion, right part of colon	First and second stages: carcinoma	Two stage resection	Recovered from operation
5	Cecal carcinoma	Cecal carcinoma	Cecal carcinoma	One stage resection	Well with normal bowel on roentgen ray study 1 yr. later
6	Cecal mass, possibly malignant	Operable lesion involving terminal part of ileum and possibly cecum	Cecal mass, malignant (?)	Two stage resection	Well 6 yr. later
7	Cecal carcinoma	Carcinoma of tip of cecum or appendix	Perforating carcinoma, head of cecum	Exteriorized	Well with normal bowel on roentgen ray study 4 yr. later
8	Subacute appendicitis, abscess (?)	No roentgenogram of colon	Cecal carcinoma	Exteriorized	Well 2 yr. later
9	Granuloma of appendix stump, carcinoma (?), regional enteritis (?)	Deforming lesion of cecum	Cecal carcinoma	One stage resection	Well 2 yr. later
10	Cholecystitis, cholelithiasis	Nonfunctioning gallbladder; no roentgenogram of colon	Cecal mass, malignant (?); cholelithiasis	One stage resection	Well 5 yr. later
11	Cholecystitis, appendicitis	Normally functioning gallbladder; no roentgenogram of colon	Ileocecal mass, suggestive of carcinoma	One stage resection	Repeated drainage and abscess formation from fistula; no evidence of regional enteritis by roentgen ray 7 yr. later
12	Cecal tumor, appendicitis (?)	Cecal lesion (?)	Ligneous cecal infection	Appendectomy	No known recurrence of bowel trouble at death 7 yr. later
13	Cecal tumor, appendical abscess (?)	Roentgenogram of colon unsatisfactory	Old chronic suppurating appendicitis	Appendectomy	Good recovery from operation
14	Abdominal tumor; exploration elsewhere, diagnosed retroperitoneal lipoma	Indefinite mass extrinsic to right part of colon	Granuloma from old perforated appendix	Appendectomy	Well 11 yr. later; small bowel obstruction from adhesions 10 yr. after operation
15	Cecal carcinoma, appendical granuloma (?)	Obstructing cecal lesion, probably carcinoma	First stage: cecal carcinoma; second stage: granuloma from old perforated appendix	Ileocolostomy, appendectomy	Well 1 yr. later
16	Obstructing carcinoma, right part of colon	Distortion of right part of colon, nature lesion indeterminate	Granuloma from old perforated appendix	Appendectomy	Well 3 yr. later
17	Cecal carcinoma	Cecal carcinoma	Probably inflammatory tumor	One stage resection	Died seventh postoperative day
18	Elsewhere: cecal carcinoma: at clinic: recurrent appendicitis	Colon normal	Inflammatory tumor, terminal part of ileum and cecum	One stage resection	Well 5 yr. later
19	Cecal tumor, tuberculosis (?)	Filling defect of cecum and sigmoid	Inflammatory mass attached to abdominal wall and sigmoid	One stage resection	Roentgenogram of colon normal 19 yr. later
20	Cecal mass (?), inflammatory: tuberculosis (?)	Blind loop of bowel in cecal area	Mass of adhesions, enlarged nodes; no definite tumor	Two stage resection	Well 14 yr. later

difficulties experienced in the diagnosis of this disease. The case numbers are those used in tables 1, 2 and 3.

CASE 2.—A 69 year old man was admitted to the hospital in a state of subacute illness of four months' duration with a history of intermittent pain in the left upper abdominal region varying from sharp to dull in intensity. His attacks lasted as long as a week and were not related to effort or intake of food. The intake of sodium bicarbonate and food did not relieve them. For one week preceding his admission the pain had shifted to the right middle and lower portions of the abdomen and had become more severe, especially at night. There was no vomiting, constipation or diarrhea, but he had noted anorexia for several months and mild nausea for a week. The patient himself had detected a mass in the right side of the abdomen five days previously. Physical examination disclosed a tender mass in the right flank extending from the brim of the pelvis to a point above the umbilicus. He had considerable arteriosclerosis, and his pulse showed frequent extrasystoles. The value for hemoglobin was 78 per cent, the erythrocyte count was 4,290,000 per cubic millimeter of blood and the leukocytes numbered 12,400. There was albuminuria, grade 1, and pyuria, grade 1 (on a basis of 1 to 4, with 1 representing the least and 4 the most severe condition). Roentgenologic studies of the colon made with the aid of barium sulfate showed a filling defect in the hepatic and transverse portions.

The abdomen was explored after a diagnosis of perforating carcinoma of the ascending colon or possibly diverticulitis had been made. A large mass, which surrounded the cecum and ascending colon and which the surgeon considered malignant, was resected.

The patient's postoperative course was extremely stormy, and cardiac and respiratory failure developed. He died on the fifth postoperative day. Postmortem examination revealed generalized peritonitis.

On surgical pathologic examination the specimen was found to consist of 20 cm. of ileum, the appendix, cecum, ascending colon and 8 cm. of transverse colon (fig. 1). In the center of the tumor a twisted, retrocecal and retroileal appendix was found. In the midportion of the appendix there was a small perforation leading to an abscess 3.0 by 1.5 by 1.0 cm. which lay between the appendix and the adherent cecum.

On microscopic examination sections of the appendix at the site of rupture showed absence of the mucosa and the presence of dense infiltration with lymphocytes, monocytes and a few scattered polymorphonuclear leukocytes. This reaction involved all coats of the appendix and was interspersed with a dense proliferation of fibroblasts which almost replaced the muscularis propria. The fibrosis extended into the fat of the mesoappendix. The walls of the abscess cavity and the overlying cecum revealed a dense infiltration with polymorphonuclear leukocytes, monocytes, lymphocytes and occasional plasma cells. In some areas fibroplastic activity was intense. The adherent mesentery was involved by a similar acute and subacute inflammatory process, largely perivascular in distribution and characterized by the presence of dense bands of fibrotic tissue.

The preceding case illustrates a relatively insidious onset and an atypical location of the pain early in the process, with the subsequent development of a huge tumor which became evident to the patient himself. It also illustrates the danger of primary one stage resection as a means of surgical relief.

CASE 9.—Fourteen months before her admission to the hospital a young woman, aged 21, after feeling run down for several months and losing 20 pounds (9.1 Kg.), began to have abdominal cramps and pain in the right lower quadrant. At operation elsewhere a gangrenous appendix was removed. The convalescence was normal. She remained well until three weeks before her admission, when she noted vague distress in the lower abdominal region and ten days later detected a tender mass in the right lower quadrant, which increased in size slightly. A week before her admission she began to have severe pain in the right lower quadrant, which was relieved by vomiting. At the same time her temperature rose to 99.0 F.

Physical examination revealed a well developed young woman with a movable, tender, tympanitic mass, 6 cm. in diameter, under a healed scar at McBurney's point.

Fig. 1 (case 2).—Granuloma opened to show overgrowth of dense fibrous tissue. Note the white probe in the perforation of the appendix.

The hemoglobin measured 12.1 Gm. per hundred cubic centimeters of blood, the erythrocytes numbered 3,980,000 and the leukocytes count was 6,900 per cubic millimeter of blood. The urine was normal. Roentgenologic studies disclosed a deforming lesion of the cecum.

The diagnoses of granuloma of the appendical stump, neoplasm and regional enteritis were considered, and exploration was carried out. The surgeon found a mass associated with considerable glandular involvement; he thought the lesion was a carcinoma and carried out a primary resection.

The patient made a good recovery and was well two years later.

The gross pathologic specimen consisted of 13 cm. of the terminal part of the ileum and 14 cm. of cecum and ascending colon. The base of the cecum and the terminal part of the ileum were adherent to a glandular tumor mass 5 by 5 cm. lying posteromedially to the ileocecal junction. In the center of the mass was an abscess cavity 2 by 2 by 1 cm. surrounding a heavy linen ligature and a small silk suture. The linen suture had been tied in a double loop and the ends measured 1.5 cm. in length. Undoubtedly these were the materials used to tie off the stump of the appendix at the time of the previous operation.

Microscopic examination of the wall of the overlying cecum disclosed some increase in lymphocytic tissue, with a few plasma cells and polymorphonuclear leukocytes in the mucosa. The submucosa and muscularis were greatly thickened and densely infiltrated with eosinophils, plasma cells, lymphocytes and fibroblasts. The lymphocytes formed germinal follicles, and an occasional foreign body giant cell was present.

Sections from the abscess showed the center to be formed largely of polymorphonuclear leukocytes and necrotic debris, while the walls were formed of dense fibroblastic tissue which contained a few polymorphonuclear leukocytes and many lymphocytes.

The foregoing case illustrates how mild may be the symptoms of these lesions, since undoubtedly the pathologic process began soon after appendectomy and was likely due to the presence of nonabsorbable ligatures used in excessive amounts, although no symptoms appeared for over thirteen months.

CASE 15.—A 77 year old surgeon had noted a mass 1 to 2 inches (2.5 to 5 cm.) in diameter occurring in the right lower quadrant off and on for three years. It was sometimes tender, and he had occasional twinges of pain in this region. Six months before his admission to the hospital one of these attacks lasted longer than usual. At surgical exploration elsewhere a perforated appendix with abscess was found, and the latter was drained. Periodic drainage of the wound followed, and the mass remained.

Physical examination at the clinic revealed a well nourished man in apparent good health. There was a small sinus in the old appendectomy scar, and underneath it there was a smooth mass the size of an orange.

The hemoglobin measured 14.8 Gm. per hundred cubic centimeters of blood, the leukocyte count was 11,400 per cubic millimeter of blood and the sedimentation rate was 54 mm. in one hour. The urine was normal. Roentgenologic studies of the colon revealed a malignant-appearing lesion, probably carcinoma, which was obstructing and deforming the cecum.

The clinical diagnosis was probable carcinoma of the cecum, with the possibility of granuloma of the appendix being considered.

Surgical exploration revealed, in the neighborhood of the cecum, an orange-sized mass which had perforated laterally. Dissection was difficult, and since there were adherent loops of the terminal part of the ileum an ileotransverse colostomy was done. Recovery was rapid, and reexploration was carried out a month later for removal of the growth. The mass had decreased in size in the interval, and a thickened fibrotic appendix could be felt behind the cecum. The appendix was found to have ruptured at the tip and to have become fixed to the abdominal wall at the site of original drainage. Removal was accomplished. The patient was well when he was last heard from, a year later.

The appendix and its mesoappendix measured 4 by 2 by 1 cm. The mucosa contained a few polymorphonuclear leukocytes and many lymphocytes, with an increase in toxic lymph follicles. The lumen contained purulent material. The walls were the site of microscopic abscesses about which there was a dense fibroplastic reaction as well as diffuse infiltration with monocytes and lymphocytes. This process extended into the mesoappendix. In the distal portion a false diverticulum was present at the site of previous perforation. This part was the site of diffuse subacute and chronic inflammation.

The preceding case illustrates the degree to which these tumors may shrink when a shunting procedure is done. In this instance the surgeon was able to identify the appendix as the cause of the trouble and to effect cure by performing appendectomy a month after ileocolostomy had been done.

CASE 17.—A 55 year old Jewish man came for examination solely because he had found a mass in the right lower quadrant one week previously. He denied having any pain in this region but did admit having a sense of discomfort in the lower abdominal region.

Physical examination revealed arteriosclerosis and a nontender mass the size of an orange in the right lower quadrant.

The value for hemoglobin was 76 per cent, the erythrocytes numbered 4,290,000 per cubic millimeter of blood and the leukocytes 9,200. The urine contained albumin, grade 1, and pus cells, grade 1. The roentgenogram of the colon was reported as showing a defect in the terminal part of the ileum and the cecum, interpreted as being "95 per cent malignant."

The clinician agreed with the roentgenologic diagnosis, and the surgeon found a large tumor which he thought to be inflammatory. Resection was accomplished without breaking into pus. The patient did poorly after operation and died of peritonitis on the seventh day postoperatively.

The specimen removed at operation consisted of 6 cm. of the terminal part of the ileum and 11 cm. of cecum, appendix and ascending colon. The appendix was coiled up to the left of the cecum, lying between the latter and the ileum. Surrounding the appendix was a hard mass of granulation tissue 5 by 4.5 by 4 cm. which filled the interval between the ileum and cecum and extended behind the cecum. In the center of the appendix was a small perforation leading to an abscess 3 cm. (fig. 2*a*) in diameter which lay against the cecum.

On microscopic examination a section through the mass near the abscess showed that the muscosa of the appendix was represented by a single layer of flattened columnar epithelium and a few remnants of glands (fig. 2*b*). These lay along one side of the abscess, and the remainder of the appendix was replaced by microscopic abscesses and fibrous tissue, leaving only a few separated fibers of the muscularis. The abscesses were filled with polymorphonuclear leukocytes and were surrounded by dense fibrous tissue which contained foci of polymorphonuclear leukocytes and monocytes. There was remarkably little vascularization of the granulation tissue, and many of the arteries were almost obliterated by thickening of the media and, to a lesser extent, by intimal swelling.

In the adjacent cecum replacement of the subserosa and muscularis by inflammatory granulation tissue had occurred, with edema and fibrin deposits being present in the submucosa. There was some increase in number of lymph follicles in the submucosa and mucosa.

Fig. 2 (case 17.—(*a*) Large section through the granuloma. In the appendix in the lower right hand corner there is a perforation leading to the multiloculated abscess which is surrounded by dense fibrous tissue. Note the almost normal ileal mucosa on the left. This patient had no symptoms in spite of the size of the tumor and amount of inflammation in it (× 2). (*b*) Section through the wall of the appendix near the perforation. There is marked atrophy of the mucosa, with dense infiltration of the submucosa by polymorphonuclear leukocytes (hematoxylin and eosin, × 45).

The preceding case is interesting because of the almost complete absence of symptoms in spite of the presence of a highly inflammatory lesion, the removal of which ended in fatal peritonitis. The danger of primary radical surgical removal of these lesions is further emphasized.

FINDINGS IN THE TWENTY CASES IN THIS STUDY

Incidence.—These lesions are rare, occurring in approximately 1 in 75,000 patients admitted to the Mayo Clinic.

Age and Sex.—The average age was 52.1 years, and if cases are excluded in which previous operation was partly responsible for the pathologic process, the average age was 54.8 years. There was no significant sex predilection.

Etiology and Pathogenesis.—Perforation: The majority of these tumors arose on the basis of perforative disease of the appendix. In 10 cases there was definite evidence of perforation, in 3 perforation was probable, in 1 there was gangrene of the tip and in 3 there were only varying degrees of inflammation (table 2).

The 5 cases in which only the appendix was removed are interesting in this regard. In these there was evidence of healed perforation along the mesenteric border at the site of entrance of the appendical vessels (fig. 3*a*). These could be identified grossly by the finding of slitlike breaks in what appeared to be normal muscularis. Microscopically, the mucosa did not pouch out, but the inflammatory process in the submucosa streamed through the relatively intact muscularis at these points. It would appear that as a result of a slow dilation of the lumen a pseudodiverticulum had formed and ruptured at these weak points in the muscularis. Later the mucosa had retracted and healed. The anatomic basis for this hypothesis has been well illustrated by Kelly and Hurdon [23] in a photograph which demonstrates the outpouchings of the mucosa at the point of the vessel attachments after enucleation of the mucous membrane. In these cases the main mass was in the appendix and its mesentery, so that it could be identified and removed. These differences in the site of perforation may be the pathologic basis for Läwen's classification of the lesions under fibroplastic appendicitis in the narrower and wider sense. That the appendixes showed no external evidence of perforation supports Chauvenet's [24] observation of complete macroscopic healing of a perforation in ten days.

23. Kelly and Hurdon,[9] p. 142.

24. Chauvenet, cited by Bernard and Milone.[2a]

Location of Appendix: The fact that the acute inflammatory changes could occur with such meager symptoms was largely due to the anatomic position of the appendixes (table 2).

In 13 of the 15 cases in which the site of the appendix could be determined it was retrocecal, retroileal or curled up in the ileocecal angle. In 1 patient the appendix was buried in the lateral cecal wall,

TABLE 2.—*Summary of Pathologic Findings*

Case	Size of Lesion, Cm.	Appendix		Abscesses *
		Position	Perforation	
1	9 by 7 by 6	Retrocecal, retroileal	Probable old perforation	3
2	12 by 7 by 6	Retrocecal, retroileal	Definite perforation	3
3	2 by 1.5 by 1.5	Retrocecal, only stump identified	Distal portion sloughed off	0
4	6 by 2 by 1.5	Retroileal	Gangrenous tips, no perforation	0
5	4 by 3.5 by 1.5	Retroileal	Old perforation	0
6	2 by 2 by 2	Ileocecal angle	Probable old perforation	0
7	6 by 4.5 by 4	Ileocecal angle	None	2
8	7 by 6 by 6	Ileocecal angle	None	0
9	5 by 5 by 5	Not present	Previously nonperforated gangrenous appendix	3
10	5 by 5 by 4	Retroileal	Old perforation	2
11	8 by 7 by 6	Retrocecal, retroileal	Old perforation	3
12	Not stated, mass of indurated tissue	Not stated	Old healed perforation into mesoappendix	?
13	Not stated	Lateral to cecum	Old healed perforation into mesoappendix	3
14	Not stated	Not stated	Old healed perforation into mesoappendix	2
15	Small orange	Retrocecal	Old healed perforation; false perforation	2
16	4 by 4 by 4	Buried in base of cecum	Old perforation into mesoappendix	1
17	5 by 4.5 by 4	Ileocecal angle	Probable old perforation; walls replaced by fibrosis and abscesses	4
18	3.5 by 3 by 3	Ileocecal angle	None	1
19	9 by 5 by 2.5	Not present	Previous rupture and partial removal	3
20	2 by 1.5 by 1	Not present	No previous perforation; partial removal	1

* Graded from 1 to 4, in which 1 denotes the least severe and 4 the most severe condition.

and it is interesting that after a prolonged complaint of dull pain in the right lower quadrant there developed pain in the right hip which was aggravated by walking. This was probably due to extension of the process to the iliopsoas muscle. In the remaining case the appendix was buried in the base of the cecum. Thus, in all these 15 patients, the appendix was so situated that as long as the inflammatory process remained localized, which was readily accomplished by a sealing off

of the pocket in which it lay, only visceral sensation would be stimulated.

Relation of Age to Occurrence of Lesion: The tendency for these lesions to remain localized and not to go on to frank abscess formation

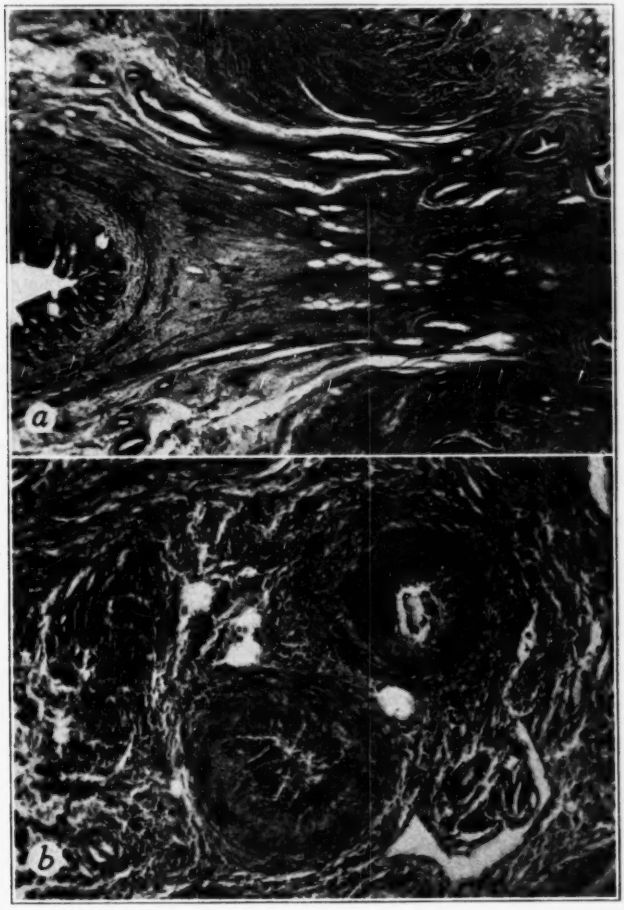

Fig. 3.—(*a*) Section through old healed perforation into the mesoappendix at the site of entry of the blood vessels. Note the almost normal muscularis at the top and bottom on the right. The mucosa on the left has healed, leaving inflammatory tissue in the submucosa; this tissue extends out into the mesoappendix along the vessels through the defect in the muscularis (hematoxylin and eosin, × 25). (*b*) Section through arterioles in the granuloma. Note increase of hyaline fibrous tissue in the media and almost complete occlusion of the lumen as a result of this increase of fibrous tisue and endothelial thickening (hematoxylin and eosin, × 115).

may well be related to age. Dennis and his co-workers [25] have conclusively demonstrated that in youth the healthy appendix is an organ of secretion and as a consequence obstruction leads to rupture, with the appendix capable of producing a considerable amount of fluid. They also pointed out that as atrophy took place in the older patients, secretion decreased and could disappear. It is possible that in the persons included in this series, obstruction from whatsoever cause might have produced a slow rate of distention and mild inflammatory changes. This would have allowed time for adhesions to wall off the site of inflammation, and the subsequent perforation could have completed the process of atrophy so that the organ ceased to pour out sufficient fluid to spread the infection beyond the encircling adhesions. This line of reasoning was corroborated by the frequency of occurrence of flattening and fibrous replacement of the mucosa seen in the specimens (fig. 2*b*). The diseased organ, however, would have remained behind and would have been subject to recurrent mild exacerbations of inflammation leading to still further additions to the ensheathing granulomatous tissue. This possibility was supported by the frequency of occurrence of a history of intermittent attacks of pain over long periods.

Foreign Bodies: Intraluminal foreign bodies did not appear to be important causes of the lesions. In 1 case a nonmetallic foreign body had caused much erosion and inflammation of the wall and may well have initiated continued low grade inflammation without perforation. In another case fecaliths had been present when the appendix was previously removed.

Atrophy and Fibrosis: Most of the appendixes showed old chronic fibrous replacement, but it was difficult to say whether this type of process had been responsible for the initial obstructing lesions which had led to perforation and inflammation.

Residual Stumps: In 2 cases the appendix had been partly removed elsewhere and the granuloma had formed about the short remaining segment. In 1 the stump was filled with pus and the walls were fibrotic, thus transforming the stump into a chronic abscess. In the other the wall was not severely damaged but there was decided inflammation around the distal end as though at some time inflammatory products had leaked out at this point.

Suture Material: In 1 case the lesion may have resulted from the use of an excessive amount of heavy linen ligature and silk purse-string suture in removal of a gangrenous appendix. These foreign bodies

25. Dennis, C.; Buirge, R. E.; Varco, R. L., and Wangensteen, O. H.: Studies in the Etiology of Acute Appendicitis: An Inquiry into the Factors Involved in the Development of Acute Appendicitis Following Experimental Obstruction of the Appendical Lumen of the Rabbit, Arch. Surg. **40**:929-948 (May) 1940.

were the focal point for the inflammation and may have formed an intramural abscess between them, as postulated by Nemilov.

Vascular Factors: An unusual degree of thickening of the media of the arterioles was present in 14 cases. This varied from moderate stenosis of the lumen to complete obliteration (fig. 3*b*). The exact significance of this finding could not be determined, but it was probably the result of inflammation and possibly the result of extrinsic pressure of the fibrous tissue. This process may set up a vicious cycle of necrosis and further spread of infection, as postulated by Mock.

The avascular nature of the lesions may explain the lack of systemic infection shown by the patients as a result of the absence of absorption from the inflamed tissues.

No evidence was found to support the theories of retrograde arterial thrombosis or of venous thrombosis.[26] The patient in case 11 did give a history of transient jaundice with his attacks, which might have been the result of low grade pylephlebitis, but this could not be proved.

Lymphatic Vessels: Moderate edema was found especially in the submucosa in many of the cases, but true lymphedema was not seen. Where inflammation was reasonably active, the ileocecal nodes were enlarged and were the sites of chronic inflammatory changes and fibrosis.

Fibroplastic Diathesis: None of the patients showed a tendency toward any other type of fibroplastic process.

Pathologic Findings.—The tumors exhibited varying degrees of acute, subacute and chronic inflammation. There frequently were microscopic abscesses filled with polymorphonuclear leukocytes, and at times these abscesses coalesced to form small, grossly evident abscesses. In other parts of the lesion there were foci of lymphocytes which were sometimes forming germinal follicles. In all specimens there were regions characterized by scattered infiltration with lymphocytes and monocytes and sometimes plasma cells and eosinophils. Often these cells were perivascular in distribution.

The large bulk of the mass was made up of dense fibrous connective tissue of all degrees of maturity from that of loose fibroblastic proliferation with numerous capillary buds to old, dense, avascular scar tissue. The proportion of inflammatory exudate and fibrous tissue varied greatly in different tumors. Many of the lesions evidenced thickening of the media of the arterioles, at times leading to obliteration (fig. 3*b*). The lymph nodes were the sites of only chronic inflammatory changes. The mucosa of the ileum and colon, at most, was the site of mild chronic inflammation at the points of adherence to

26. Bernard and Milone.[2a] Fiolle, Luccioni and Lluccia.[2e]

the granuloma. The granulomatous tissue sometimes extended into the muscularis and submucosa. Occasionally the ileal muscularis was hypertrophied in cases in which there was associated ileocecal obstruction.

Foreign body giant cells were rarely seen and then usually around necrotic debris which contained fragments of foreign material; this material was possibly contents of bowel which previously had been extruded. In 2 cases there were foci of fat necrosis in the involved mesentery.

Contiguity would seem to have explained the spread of infection in most cases, though the lymphatic route [27] was probably an accessory factor.

Symptomatology.—The symptoms were so varied in degree (table 3) and character that it was difficult to ascribe any set pattern to this disease process. Pain was present in all cases at one time or another. It commonly was intermittent, generalized and crampy at first, with localization in the right lower quadrant as either crampy pain or dull residual soreness lasting a few days after attacks. It had persisted for periods ranging from ten days to three years, but when present for long periods it had been so mild that medical advice had not been sought. Often there was a history of a more serious attack in the few days or few weeks preceding admission to the hospital, and when this episode had been severe an acute reactivation in the center of the mass was usually found. Crampy pains often indicated stenosis of the ileocecal valve. Two patients had pain suggestive of biliary disease, and in 2 others the pain extended to the right hip. One man denied having any pain; he had some vague discomfort in the lower abdominal region.

Nausea and vomiting were infrequent and mild, usually accompanying exacerbations of pain and subsiding in a few days.

In only 2 patients did there develop severe obstruction necessitating ileocolostomy. Nine patients had mild complaints of constipation, fulness and borborygmi, relieved by enemas or passage of flatus. One patient had slight, transient diarrhea, and 1 noted bright blood in the stool, probably due to concomitant hemorrhoids.

Seven patients had low grade fever during exacerbations,[2b] which subsided in a short time. Four complained of mild anorexia. Six showed a little loss of weight, while 1 man slowly lost 30 pounds (13.6 Kg.) in three years.

Physical Findings.—The patients were not severely ill except when recent surgical procedures had been done. The only common finding was a tender mass in the abdomen. A mass was found in 15 cases,

27. Jamieson, J. K., and Dobson, J. F.: The Lymphatic System of the Caecum and Appendix, Lancet **1**:1137-1143 (April 27) 1907.

a questionable mass was noted in 3 cases and no mass could be felt in 2. When present, the lump varied from the size of an egg to that of a grapefruit and was in the right middle or lower quadrant (table 3). Four patients first detected the tumor themselves, and the home physician found it in 6 others; twice the tumor was found at laparotomy. It was slightly to moderately tender in 12 patients and nontender in 4 of the 16 patients who had a mass. In addition, 1 patient had epigastric tenderness, while another had tenderness only in the epigastrium and not over the tumor. Rigidity was found once.

Laboratory Findings.—Hemoglobin Content and Erythrocyte Count: The degree of anemia was moderate, with an average erythrocyte count of 4,204,000. The lowest reading was 3,310,000 and the highest 4,780,000. The hemoglobin was in an equivalent range, though one reading was abnormally high at 17.9 Gm. per hundred cubic centimeters of blood (table 3).

Leukocyte Count: The leukocyte counts were suprisingly low, considering the degree of inflammation present in many cases. The average count was 10,025, and the range was from 4,600 to 17,000. In only 9 cases was the count over 10,000. In case 17, in which there was a fair-sized abscess cavity, the leukocyte count was 9,200.

Sedimentation Rate: In the 2 cases in which this test was done the results were respectively 76 and 35 mm. in one hour by the Westergren method.

Occult Blood: Tests for occult blood were made in only 4 cases. The only positive reaction was in case 6, in which the bleeding was probably due to hemorrhoids.

Urinalysis: There were no significant urinary symptoms in spite of the fact that the right ureter was close to the site of the inflammatory process in most cases; the ureter was involved in 1 case.

Roentgenologic Diagnosis.—Satisfactory studies of the colon were made in 15 cases. One of these studies was reported as giving negative results. In 4 cases a diagnosis of carcinoma was made (table 1).

Roentgenologic examination usually reveals evidence of an extracecal and extraileal mass which separates the terminal part of the ileum from the head of the cecum and displaces the latter structure to the right (fig. 4). There is frequently a smooth, convex indentation on the medial side of the cecum. The mass is palpable outside the lumens of the terminal part of the ileum and the cecum. There is usually a significant absence of the typical neoplastic changes on the mucous membrane surface of the bowel. Neoplasm will always manifest itself primarily on this surface. In order to determine these features the roentgenologist must be sure to identify the anatomic structures of the ileocecal coil. To do this he must visualize the appendix or the terminal part of the ileum, or he must be able to see the ileocecal

TABLE 3.—*Summary of Clinical Findings*

Case	Pain			Duration	Nausea*	Vomiting*	Obstruction*	Temperature, F.	Tenderness, Severity* and Site	Mass, Site	Erythrocytes	Hemoglobin	Leukocytes
	Severity, Grade*	Type	Site in Abdomen										
1	2	Intermittent sharp; stinging soreness with straining	Periumbilical shifting to right lower quadrant	8 days	0	0	Constipation, 1	0	2. Right side	Cecal region	3,960,000	....	9,200
2	1 to 2	Intermittent dull; sharp with last attack	Left upper quadrant, shifting to umbilical area and right lower quadrant	21 mo.	1	0	0	0	3. Over mass	Midabdominal region, right lower quadrant	4,290,000	78%	12,400
3	3	Intermittent crampy	Generalized	3 wk.	0	0	Borborygmi, relief with enemas	0	2. Over mass	Right lower quadrant	4,290,000	....	4,600
4	1	Intermittent mild twinges	Right lower quadrant	24 mo.	1	0	Constipation, 1; borborygmi, 1	0	2. Over mass	Right lower quadrant	4,080,000	....	17,000
5	1 to 3	Intermittent sharp; steady soreness	Generalized, right lower quadrant	36 mo.	1	1	Periodic constipation, 1	0	0. Over mass	Right lower quadrant (doubtful)	4,200,000	....	7,300
6	2 to 4	Intermittent colicky; steady soreness	Right lower quadrant and left upper quadrant	3½ mo.	0	0	Bloating and borborygmi, 1; complete obstruction	101 to 102, 1 attack	2. Pelvis	Right lower quadrant	3,310,000	....	9,800
7	1	Intermittent	Right lower quadrant	7 mo.	0	0	0	0	1. Over mass	Right lower quadrant	3,700,000	12.7 Gm.	7,400
8	1 to 2	Intermittent sharp; dull constant	Right lower quadrant	12 mo.	0	0	Bloating, 10 days	100.3, 10 days	2. Right side	Right lower quadrant	.....	....	15,900
9	1 to 3	Abdominal discomfort in lower region; severe cramps	Right lower quadrant	3 mo.	0	2; 1 wk.	0	99, 3 wk.	1. Over mass	Right lower quadrant	3,960,000	12.1 Gm.	6,900
10	1 to 2	Intermittent crampy	Midabdominal to back and scapula on right	18 mo.	0	0	Bloating, relief when flatus passed	0	0.	Not present	.....	17.9 Gm.	10,900
11	2	Intermittent colicky to steady soreness	Epigastric; right lower quadrant	12 mo.	2	2	0	Chills, fever	2. Epigastrium	Not present	.....	14.6 Gm.	10,300
12	1 to 3	Intermittent soreness	Right upper quadrant; back on right	6 mo.	0	2	Constipation, 1	0	2. Epigastrium, over mass	Right lower quadrant	3,800,000	....	6,700
13	1	Intermittent soreness	Right lower quadrant; right hip	36 mo.	0	0	0	99.3	1. Over mass	Right lower quadrant	4,240,000	68%	6,700
14	3	Intermittent sharp	Right lower quadrant	48 hr.	0	0	0	?	0.	Right lower quadrant	4,460,000	....	7,900
15	1	Intermittent soreness	Right lower quadrant	36 mo.	0	0	0	0	1. Over mass	Right lower quadrant	4,160,000	14.8 Gm.	11,400
16	2	Intermittent crampy to steady soreness	Generalized and in right lower quadrant	2 wk.	0	0	Distended, 3 days	0	0.	Right lower quadrant	4,780,000	....	9,200
17	1	Slight discomfort	Lower part of abdomen	?	0	0	0	0	0.	Right lower quadrant	4,290,000	76%	9,200
18	2	Intermittent grabbing and soreness	Epigastric; right lower quadrant	8 mo.	0	0	0	0	0 to 1. Cecal region	Cecal region (doubtful)	4,560,000	....	13,700
19	3	Intermittent colicky	Lower part of abdomen	13 mo.	0	1	0	100 to 101.2, 2 wk.	0.	Right lower quadrant	4,560,000	75%	11,000
20	3	Intermittent cramps	Generalized, right lower quadrant	13 mo.	1	1	Complete obstruction; constipation, 2	100 to 101, 2 wk.	1.	Right lower quadrant (doubtful)	4,710,000	68%	13,000

* Symptoms graded 1 to 4, with 1 representing the least and 4 the greatest severity.

valve, with filling of both the terminal part of the ileum and the cecum. A motor test meal may be necessary in addition to the barium enema but it must be remembered that the obstructive symptoms may contraindicate use of it. In none of these cases was the appendix visualized.

Clinical Diagnosis.—In 10 cases the primary diagnosis was carcinoma of the cecum, in 4 tumor, in 3 appendical disease, in 2 cholecystitis and in 1 an inflammatory mass, probably tuberculous (table 3). In 9 cases appendical granuloma or subacute appendicitis was seriously considered in the differential diagnosis.

Fig. 4.—Typical filling defect in the interomedial wall of the cecum, displacing the cecum laterally and the terminal part of the ileum medially. The mucosal pattern, however, is still preserved.

An accurate preoperative diagnosis is most difficult to make, and some of these tumors imitate carcinoma in almost every respect. The main diagnostic point revealed by this study was a history of intermittent attacks of moderately severe crampy pain which was often referred to as soreness in the right lower quadrant. Nausea, vomiting, fever, anorexia, loss of weight and obstruction were not common or severe. No patient complained of melena, 1 had mild diarrhea and 4 had mild constipation. A tender mass was the only physical finding. Anemia was slight, and the white blood cell count was usually slightly increased. It is possible that more frequent use of the sedimentation rate would have shown a consistent increase suggesting the inflam-

matory nature of the lesion. Also the occurrence of negative reactions to tests for occult blood in the stool would favor the diagnosis of granuloma.

Surgical Diagnosis.—Eleven times the surgical diagnosis was that of a malignant lesion (table 1). On five occasions the correct diagnosis was made, and in 4 cases the lesion was called "inflammatory" and was resected. Biopsy was seldom done. The reasons for not taking specimens for biopsy were the apparent conclusive gross evidence of a malignant process, the presence of partial obstruction demanding surgical intervention and the danger of soiling consequent to the taking of a sufficiently deep block of tissue to eliminate perforating carcinoma as the diagnosis.

The danger of trusting to gross appearance and superficial biopsy was illustrated in 2 cases reviewed in the course of this study. In 1 a diagnosis of encapsulated abscess of the appendix was made and ileocolostomy was done. Three months later laparotomy revealed inoperable colloid carcinoma. In the other case the appendix was removed for ligneous inflammation and three and a half years later an inoperable colloid carcinoma was found.

No evidence was found to support the contention of Bernard and Milone that in these lesions a definite line of cleavage leading to the offending appendix can be found behind the cecum.

Course.—It is hard to establish, from this study, what the normal course of this process is, as in all cases the process was modified by surgical interference. Certain inferences, however, can be justifiably made. There would seem to be a nice balance between continuation of the granulomatous process and resolution of the inflammatory elements, leaving a mass of dense fibrous adhesions. In all probability, case 18 illustrates a pronounced degree of spontaneous remission of a granuloma. In cases 3, 4, 6, 15 and 20 evidence of considerable involution followed ileocolostomy. In case 15 the occurrence of involution enabled the surgeon definitely to establish the appendix as the cause of the trouble at the time of the second stage, so that appendectomy alone was done. In 1 other case, the record of which was studied but was not included in the series because no tissue was available for study, a questionably malignant or inflammatory tumor, according to clinical and roentgenologic evidence, resolved so completely after ileocolostomy that the second stage was not done. Reexploration for other causes on two later occasions revealed nothing but dense fibrous adhesions.

Furthermore, in cases 12, 13, 14, 15 and 16 removal of the appendix caused clinical and, in some, roentgenologic evidence of subsidence of the tumor; this evidence in case 14 was confirmed ten years later at laparotomy.

In the absence of surgical intervention the normal course would seem to be repeated exacerbations with increase in size until obstruction takes place at the ileocecal valve or elsewhere from kinking of adherent loops of bowel.

Treatment.—The results of surgical intervention in these persons were gratifying. They were followed for periods ranging up to nineteen years without evidence of recurrence of trouble with the exception of the patient in case 11, who was never completely cured from the beginning (table 1).

One patient not included in this series did well after simple coring out of the appendical mucosa. Four patients were cured by means of appendectomy. One of these had intestinal obstruction from an adhesive band ten years later but remained well after that. One patient remained well after ileocolostomy and appendectomy. Six patients who underwent exteriorization procedures or two stage resections recovered and retained good health.

Two of 9 patients subjected to a one stage resection died of peritonitis, a fact which suggests that this radical procedure is dangerous in the treatment of these infectious lesions. In addition, in 1 patient there developed a pelvic abscess and fistula into the terminal part of the ileum, which continued to drain and to form abscesses for seven years, though his general health was fairly good for the first six years.

From the foregoing statements, it would seem that if the appendix can be established as the cause of the lesion, appendectomy will be curative. If the tumor can be reasonably established as inflammatory, the safest procedure is ileocolostomy or exteriorization. Shunting the fecal stream usually causes a resolution in the size of the tumor in a relatively short time. This may be sufficiently dramatic to exclude malignancy from diagnostic consideration, but careful and frequent clinical and roentgenologic rechecks are indicated to avoid missing an underlying carcinoma. Even if ileocolostomy does not resolve the question of malignancy, it almost invariably brings about sufficient reduction in the inflammatory reaction to allow for a relatively easy resection at the time of the second stage, and, as in case 15, it may make the diagnosis of appendicitis possible.

Ileocolostomy alone is not always capable of causing complete resolution, as was evidenced in case 20. Trouble repeatedly recurred because of only an infected stump of the appendix in spite of the fact that there was a properly functioning ileocolic stoma.

SUMMARY AND CONCLUSIONS

In a series of 20 cases of "ligneous cecitis" or "nonspecific appendical granuloma" most of the lesions were caused by perforative

inflammatory disease of the appendix. Incomplete removal of the appendix was responsible for the lesion in 2 of the cases, and an excessive amount of nonabsorbable suture was likely responsible in another.

The average age of the patients was 52.1 years. Their advanced ages probably account for the fact that their perforations were less acute than those usually seen.

The appendixes were usually located in the ileocecal angle or in the retrocecal or retroileal regions, permitting the rapid sealing off of the appendical inflammation. The tumor resulted from an extensive overgrowth of relatively avascular, inflammatory, fibrous tissue about the appendix after repeated attacks or low grade inflammation.

The combination of the three factors of age, location of appendix and the overgrowth of fibrous tissue accounted for the relatively mild local and systemic symptoms evidenced by the patients. The chief symptoms were recurrent attacks of midabdominal pain, with localization in the right lower quadrant. Anorexia, fever, loss of weight and melena were uncommon and were minimal when present.

The only consistent physical finding was a mass in the right lower quadrant of the abdomen. This was moderately tender in about half the cases. Anemia was not marked, and the leukocyte count was increased in half the cases. Sedimentation rates and tests for occult blood should help in evaluating the problem in these cases. The lesions have a characteristic roentgenologic appearance.

The diagnosis of these tumors is difficult. Carcinoma of the cecum is more common, and the possibility that the lesion is malignant should be excluded by all available methods before it is considered inflammatory. On the other hand, the lesions should be considered in the differential diagnosis of ileocecal masses, and no patient should be refused exploration on the basis of apparent local inoperability.

Surgical treatment resulted in cure of all but 1 of the patients who survived operation. Appendectomy will bring about cure if the appendix can be identified as the source of the trouble; otherwise, two stage resection would appear to be the safest treatment if the diagnosis is doubtful.

PROGRESS IN ORTHOPEDIC SURGERY FOR 1946

A Review Prepared by an Editorial Board of the American Academy of Orthopaedic Surgeons

XVII. INFANTILE PARALYSIS: RESEARCH

Prepared by
J. A. TOOMEY, M.D.
CLEVELAND

VIRUS STUDIES

SCHLESINGER and others [738] report that three strains of poliomyelitis virus were isolated in cases in the British Army in the Middle East. Two strains may have been related to the Lansing type, one being easily transmitted to rodents and the other being serologically of the Lansing type but not transferable; the remaining strain was not related at all and not transferable.

Olitsky and Findlay [739] make a similar report of a strain isolated in the case of a soldier with poliomyelitis in the Middle East. It was demonstrated that the strain could be substituted for the Lansing strain in neutralization tests in mice for epidemiologic purposes.

Kabat and others [740] state that the lactic acid content of the brain is significantly decreased in mice infected with the virus of poliomyelitis. This factor appears to be additional evidence for the theory that the virus may interfere in a specific manner with cell metabolism.

In his article, "Certain Properties of Theiler's Virus, Especially in Relation to Its Use as a Model for Poliomyelitis," Olitsky [741] concludes that differences in the original virus are such as to make it unusable as a model for the study of human poliomyelitis.

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738. Schlesinger, W.; Morgan, I. M., and Olitsky, P. K.: Transmission to Rodents of Lansing Type Poliomyelitis Virus Originating in the Middle East, Science **98**:452-454 (Nov. 31) 1943.

739. Olitsky, P. K., and Findlay, G. M.: The Use of the Rodent-Adapted MEF1 Strain of Human Poliomyelitis in Neutralization Tests with Serum of Apparently Normal African Natives, J. Bact. **52**:255-256 (Aug.) 1946.

740. Kabat, H.; Erickson, D.; Eklund, C., and Nickle, M.: Decrease in Lactic Acid Content of the Brain in Poliomyelitis, Science **98**:589-591 (Dec. 31) 1943.

741. Olitsky, P. K.: Certain Properties of Theiler's Virus Especially in Relation to Its Use as Model for Poliomyelitis, Proc. Soc. Exper. Biol. & Med. **58**:77-81 (Jan.) 1945.

Herbert S. Loring and C. E. Schwerdt [742] describe the method of purification of the Lansing strain of virus, and the same authors, with L. Marton,[743] describe the electron microscopy of the strain.

The conclusion of "Inactivation of Poliomyelitis Virus in Relation to Gastric and Intestinal Digestion," by Harold K. Faber and Luther Dong,[744] contains the meat of the article. The authors state that poliomyelitis virus is rapidly inactivated at the p_H levels prevailing in the stomach when only gastric juice is present and at the height of digestion of carbohydrates and of mixed meals containing meat. Pepsin contributes slightly to inactivation. The p_H levels necessary for inactivation are present in the stomach but a short part of the time, and since gastric contents are evacuated before this time unaffected virus reaches the duodenum; from then on the p_H is too high to inactivate the virus and trypsin has no effect. The authors state the belief that virus is absorbed from the intestine in this way and concentrated in the intestine, and that there is no evidence in favor of, or against, the gastrointestinal tract being the primary portal of entry. They merely have evidence that low p_H and other factors may destroy a strain of mouse-adapted virus in the stomach.

Loring [745] makes a correction about shapes of particles and concludes that the virus of human poliomyelitis, as cultivated in mice and cotton rats, consist of spherical particles about 25 millimicrons in diameter.

Lawson and Melnick [746] conclude that milk exerts a protective action against the destruction by heat of rodent-adapted virus and the virus of spontaneous poliomyelitis in mice when infected tissue from the central nervous system is heated in that medium. Suspension in milk enables these strains to withstand about 5 to 10 more centigrade degrees for thirty minutes than when the infected tissues are suspended in water. No such protection is noted when infectious intestinal contents from mice are used as a source of virus.

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742. Loring, H. S., and Schwerdt, C. E.: Isolation of a Macromolecular Constituent with Properties of the Lansing Strain of Poliomyelitis Virus, Proc. Soc. Exper. Biol. & Med. **62**:288-291 (June) 1946.

743. Loring, H. S.; Marton, L., and Schwerdt, C. E.: Electron Microscopy of Purified Lansing Virus, Proc. Soc. Exper. Biol. & Med. **62**:291-292 (June) 1946.

744. Faber, H. K., and Dong, L.: Inactivation of Poliomyelitis Virus in Relation to Gastric and Intestinal Digestion, Proc. Soc. Exper. Biol. & Med. **63**:575-578 (Dec.) 1946.

745. Loring, H. S.: Similarities in Electron Micrographs of Purified Lansing and SK Poliomyelitis Viruses, Proc. Soc. Exper. Biol. & Med. **64**:101-102 (Jan.) 1947.

746. Lawson, R. B., and Melnick, J. L.: Inactivation of Murine Poliomyelitis Viruses by Heat, J. Infect. Dis. **80**:201-208 (March-April) 1947.

The concentration of virus plays a role in its thermal lability. The more dilute the virus suspension the less heat is required to inactivate it, even when all dilutions are made in milk.

When concentrated suspensions of infected nerve tissues are heated for thirty minutes occasional traces of virus may be detected if the temperature is kept at 65 C. and 70 C., which is above the temperature commonly used in pasteurization (61.7 C.). However, the number of variables which affect this type of experiment is great; so unqualified didactic statements about the thermostability of these agents should not readily be made.

No information about human (monkey-adapted) poliomyelitis virus is furnished by these experiments.

[ED. NOTE.—It is my belief that the knowledge of the survival of of poliomyelitis virus in milk and ice cream is inadequate.]

Brutsaert and others [747] conclude that propagation of human or simian strains of poliomyelitis virus is difficult in any kind of medium, although certain murine strains grow well in tissue culture containing embryonic mouse brain. From the authors' data they conclude that results at the time of their report do not encourage the assumption that neurotrophic poliomyelitis virus in stools or sewage may be maintained in symbiosis with free living microbial cells.

ETIOLOGY AND EPIDEMIOLOGY

Hardy [748] reviews the literature concerning the etiologic agent of poliomyelitis, the theories on the method of transmission of agent to host and the theories of pathogenesis in the body.

Melnick and others [749] report that dichlorodiphenyltrichloroethane (DDT) was applied in two areas in which there were epidemics of poliomyelitis, the areas being of about 4 square miles each and inhabited by some 67,000 and 27,000 people, respectively. Under the circumstances, which were not ideal, a temporary reduction of flies was achieved in both areas, but there was no effect on the poliomyelitis epidemic in either area.

[ED. NOTE.—The inconclusive results obtained in this work cannot be accepted without further studies.]

747. Brutsaert, P.; Jungeblut, C. W., and Knox, A.: Attempts to Propagate Murine Virus on Various Intestinal Bacteria and Protozoa, Proc. Soc. Exper. Biol. & Med. **61**:265-268 (March) 1946.

748. Hardy, R.: The Etiology of Poliomyelitis and the Transmission of Its Causative Agent, Arch. Pediat. **64**:294-313 (June) 1947.

749. Melnick, J. L.; Ward, R.; Lindsay, D. R., and Lyman, F. E.: Fly-Abatement Studies in Urban Poliomyelitis Epidemics During 1945, Pub. Health Rep. **62**:910-921 (June 20) 1947.

Dauer [750] reports on the high incidence of poliomyelitis in the United States in 1946, principally in the north central part of the country. There has been a decrease in the deaths in recent years, probably due to more complete reporting and the inclusion of a greater proportion of nonparalytic cases. Poliomyelitis was more prevalent than before in other parts of the Western Hemisphere in 1946. Epidemics appear to occur more frequently in tropical areas than is commonly stated. Accumulations of epidemiologic data in recent years appear to have strengthened the hypothesis that poliomyelitis is spread principally by person to person contact.

Melnick and Penner [751] had flies infected with murine-adapted poliomyelitis virus and with Theiler's TO strain of spontaneous encephalomyelitis of mice; the excreta were positive at least five days later. The excretion of carmine (biologic inert material) took place in controls in about the same time. Human poliomyelitis virus, as naturally present in the stools of patients with poliomyelitis, was fed to blow flies (Phormia regina); after the feeding virus was found in the flies for two weeks and in their excreta for three weeks.

Wenner and Paul [752] describe a fatal case of poliomyelitis which developed in a 26 year old worker in a hospital in New Haven, Conn. He had been scratched, and eight days later symptoms began to develop. It is possible that he contracted the disease naturally, but laboratory infection was a probability. The authors isolated the virus, but they point out that the portal of entry was not determined, inasmuch as the patient acquired the disease at about the time when natural infection would be suspected. Entry may have been by way of the skin, as the man had been handling infected specimens; the incubation period was rather short for the latter type of entry.

Gebhardt and McKay [753] conclude that data on multiple cases of poliomyelitis in families show that the condition developed at the same time in different children in the majority of families, and that in these multiple cases the children had probably obtained the virus at the same time and from the same source, suggesting means other than contact as the mode of spread. Fresh unwashed or unpeeled fruits or vegetables had been eaten in 206 of a series of 206 cases of poliomyelitis surveyed. Direct contact was traced in only 13.6 per cent

750. Dauer, C. C.: Incidence of Poliomyelitis in 1946, Pub. Health Rep. **62**:901-909 (June 20) 1947.

751. Melnick, J. L., and Penner, L. R.: Experimental Infection of Flies with Human Poliomyelitis Virus, Proc. Soc. Exper. Biol. & Med. **65**:342-346 (June) 1947.

752. Wenner, H. A., and Paul, J. R.: Fatal Infections with Poliomyelitis Virus in a Laboratory Technician: Isolation of Virus from Lymph Nodes, Am. J. M. Sc. **213**:9-18 (Jan.) 1947.

753. Gebhardt, L. P., and McKay, W. M.: Transmission of Epidemic Poliomyelitis, J. Pediat. **28**:1-13 (Jan.) 1946.

of 241 cases surveyed. No evidence was found that water supplies, milk supplies or swimming pools were means by which the disease was disseminated. Bites of insects, such as flies and mosquitoes, suggest a possible means of the spread of virus. The closing of schools during the epidemic failed to reduce the incidence of the disease among the school age group.

Goldstein and others [754] state that data in the epidemic reported by them support the theory that food, possibly milk contaminated by flies, was involved. However possible, the theory is not proved.

Weaver [755] is unable to show any evidence that diets deficient in vitamin A affect the susceptibility or resistance of cotton rats to poliomyelitis when the disease is introduced in the usual ways (intracerebrally or by instillation, ingestion or contact). Cotton rats with deficient diets were more susceptible to the introduction of poliomyelitis by the intratonsillar route, by intracolonic and intranasal instillation and by subcutaneous and intracardiac injection.

Gear and others [756] were able to isolate poliomyelitis virus from the first outflow of sewage in the settlement tanks at Johannesburg, South Africa, although a second sample from the final effluent, after sand filtration, was negative.

Bigelow [757] presents the hypothesis that poliomyelitis is not a disease entity but a complication of influenza. The article is an interesting one because early influenza does look like poliomyelitis, but no student of poliomyelitis imagines that the two are the same disease.

"Epidemiological and Experimental Observations of Poliomyelitis in New York City," by Jungeblut and Dalldorf,[758] contains a small error, which is corrected in a subsequent article.

Kessel and others [759] demonstrate that strains of poliomyelitis differ in virulence when the Macaca mulatta is used and the inoculation made intracerebrally. Antigenic differences occur, but these may be relative in character.

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754. Goldstein, D. M.; Hammon, W. M., and Viets, H. R.: Outbreak of Polioencephalitis (with Poliomyelitis) Among Navy Cadets, Possibly Food Borne, J. A. M. A. **131**:569-573 (June 15) 1946.

755. Weaver, H. M.: Resistance of Cotton Rats to Virus as Affected by Intake of Vitamin A, Partial Inanition and Sex, J. Pediat. **28**:14-23 (Jan.) 1946.

756. Gear, J.; Mundel, B., and Wilson, D.: Isolation from Sewage in Johannesburg, South African M. J. **20**:139-140 (March 23) 1946.

757. Bigelow, O. P.: Anterior Poliomyelitis a Complication of Influenza, J. Indiana M. A. **39**:72 (Feb.) 1946; Infantile Paralysis a Complication of Influenza, Ohio State M. J. **42**:499 (May) 1946.

758. Jungeblut, C. W., and Dalldorf, G.: Epidemiological and Experimental Observations of Poliomyelitis in New York City, Am. J. Hyg. **43**:49-64 (Jan.); erratum, **43**:194-209 (March) 1946.

759. Kessel, J. F.; Moore, F. J., and Pait, C. F.: Differences Among Strains in Macaca Mulatta, Am. J. Hyg. **43**:82-89 (Jan.) 1946.

Melnick and Ward [760] tested flies trapped in four epidemic areas for poliomyelitis virus and demonstrated its presence in vervet monkeys in urban Chicago and in North Carolina.

Hovanic [761] reviews the question of the portal of entry in poliomyelitis.

Stokes [762] reports a case in a mother delivered of a live normal baby by cesarean section three minutes after her death.

Toomey and others [763] describe a strain of virus isolated from creek water by direct transmission to the cotton rat.

Muller [764] states that according to Petersen, the accumulation of cases of poliomyelitis after the autumnal equinox is the result of decreased resistibility; the exact cause is believed to be the great reduction in radiation during September and October, accompanied with a decrease in the length of the days. According to this hypothesis, the resistibility is a photoperiodic reaction in analogy with various remarkable reactions known in plants and animals.

Wenner,[765] in an epidemiologic study of poliomyelitis in Alabama, noted that rates of incidence were highest in epidemic years in northern rural counties consisting of villages and incorporated towns.

McFarlan,[766] in a short note on the epidemic in the island of Mauritius, mentions that there was a great prevalence of intestinal disease preceding the epidemic and that the epidemic itself occurred shortly after a cyclone, which created terrible sanitary conditions.

Gear and Mundel,[767] who studied an epidemic occurring in Johannesburg, South Africa, conclude that direct personal contact during the incubation period in 1 patient caused the spread. The statement is made that the original patient was excreting virus in the feces twelve days before symptoms appeared. Many exposed persons excreted virus, though they were otherwise unaffected.

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760. Melnick, J. L., and Ward, R.: Poliomyelitis: Susceptibility of Vervet Monkeys to Virus in Flies Collected at Epidemics, J. Infect. Dis. **77**:249-252 (Nov.-Dec.) 1945.

761. Hovanic, K. J.: Portal of Entry of Poliomyelitis, Arch. Pediat. **62**: 563-581 (Dec.) 1945.

762. Stokes, E. M.: Poliomyelitis: Failure of Intrauterine Fetal Transmission, J. Oklahoma M. A. **39**:153-154 (April) 1946.

763. Toomey, J. A.; Takacs, W. S., and Weaver, H. M.: Isolation of Poliomyelitis Virus from Creek Water by Direct Transmission to Cotton Rat, Am. J. Dis. Child. **70**:293-297 (Nov.-Dec.) 1945.

764. Muller, D.: Reason for Outbreak of Poliomyelitis During Autumn Equinox, Acta med. Scandinav. **122**:170-174, 1945.

765. Wenner, H. A.: Poliomyelitis in Alabama: Epidemiologic Considerations, Yale J. Biol. & Med. **18**:281-306 (March) 1946.

766. McFarlan, A. M.: Epidemiology of 1945 Outbreak in Mauritius, Proc. Roy. Soc. Med. **39**:323-324 (April) 1946.

767. Gear, J., and Mundel, B.: Poliomyelitis: Outbreak Occurring in Suburb of Johannesburg, South African M. J. **20**:106-110 (March 9) 1946.

Findlay and others [768] conclude that poliomyelitis is endemic in West Africa but rare in West African soldiers; the incidence among Europeans is greater than among Africans, and greater in officers than in the ranks. The authors describe a fatal case in which virus was recovered; several strains of monkeys were responsive. It is stated that the serums of West Africans contain immune bodies to the Lansing strain.

Conway and Bigwood [769] give a striking report of an epidemic in which the rate of incidence was calculated to be 288.6 cases per 100,000 persons, in striking contrast to the previous average rate of 7.5 per 100,000. Contact between patients was traced in only 28 per cent of cases. The authors have written an exhaustive article, in which it is stressed that the theory of person to person spread must be considered in the nature of a diagnosis by exclusion and that firm establishment of a diagnosis depends on a more thorough elimination of other possible explanations of the epidemiology of poliomyelitis.

Collins [770] concludes:

> Poliomyelitis as reported to health departments in the past 15 years shows an epidemic situation in some region of the United States during nearly every year. The periods of exceptionally high incidence usually extended over 2 years in which the western part of the country tends to have high rates in one year and the eastern part in the other. There is great variation in the heights of the peaks in the several geographic sections in terms of cases per 100,000 population. The peak rates tend to occur somewhat earlier in the South than in the North and West. The years 1943 and 1944 both had high rates and in 1945 rather large numbers of cases were reported in most of the geographic sections.
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> In house-to-house canvasses made a few years ago, family informants (usually mothers) reported that 5.7 per 1,000 living children 15-19 years of age had a history of poliomyelitis at some time since birth. Not all of the reported histories were paralytic; at 15-19 years of age 4.5 per 1,000 living children gave a history of a paralytic attack, and 3.0 per 1,000 had residual paralysis or muscle weakness.
>
> History rates of poliomyelitis were reported as rather consistently higher in Northeast and North Central cities than in the South. Histories of poliomyelitis were exceptionally high in the West but when paralytic cases with residual effects are considered, the West shows lower history rates than the North Central section. . . .
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> Data from a family survey on the character of the crippling effects of poliomyelitis indicate that the legs are most frequently affected. Crippling involved

768. Findlay, G. M.; Anderson, J. R., and Haggie, M. H. K.: Poliomyelitis in West Africa, J. Roy. Army M. Corps **86**:20-25 (Jan.) 1946.

769. Conway, J. A., and Bigwood, D. E., Jr.: Observations Made During Epidemic in 1944 in Hornell State Health District, New York, New York State J. Med. **46**:275-289 (Feb. 1) 1946.

770. Collins, S. D.: The Incidence of Poliomyelitis and Its Crippling Effects, as Recorded in Family Surveys, Pub. Health Rep. **61**:327-355 (March 8) 1946.

the feet or legs in 85 percent of the children under 15 years of age with residuals of poliomyelitis, as compared with 25 percent which involved the hands or arms; in a considerable proportion of the cases both the legs and arms were involved. Involvement of only the fingers or toes was negligible.

The age incidence of poliomyelitis is more similar to that of diphtheria than of scarlet fever or whooping cough. The peak rate in the survey data occurred at 3 years of age, with a fairly regular decline in incidence as age increased. Unlike most diseases, relative variation with age was greater in poliomyelitis case rates than in death rates.

Both incidence and mortality indicate somewhat lower poliomyelitis rates among girls than boys. Measures of the severity of the disease, such as the proportion of cases that were paralytic, indicate that the disease is slightly less severe in girls than boys. This is the opposite of the showing for diphtheria and is quite different from scarlet fever in which the incidence was practically identical for girls and boys.

Poliomyelitis case and death rates were lower for colored than for white persons living in the same geographic section.

Poliomyelitis death rates in the United States among residents of cities of various sizes indicate that the rate increases as size of city decreases, but rural areas and villages under 2,500 have lower rates than small cities and higher rates than cities of 100,000 and over. This general pattern holds true in the several geographic regions. ,

Cases recorded in the family survey were checked by name against health department files of reported cases in each of the 28 cities included. Also total cases for whole populations of the surveyed cities were estimated from the canvassed samples and compared with cases reported to the health departments. These two methods indicate that from 74 to 86 percent of poliomyelitis cases were reported to the health departments. . . . In the Northeast where the disease was definitely epidemic during the study year, a higher proportion of the cases was reported than in areas remote from the center of the outbreak.

Horstmann and others [771] studied 20 patients in an epidemic. Virus was isolated from 1 of 19 pharyngeal smears, 1 of 15 oropharyngeal washings and 7 of 10 stools during the first week. During the second week none of 6 pharyngeal smears, none of 7 oropharyngeal washings and 4 of 7 stools yeilded virus.

Melnick, Horstmann and Ward [772] studied the blood, oropharyngeal washings and stools of 75 patients in contact with persons with poliomyelitis, in a search for possible virus. The specimens were divided into thirteen pools of each type of specimen. No virus was detected in the blood pools; one pool of oropharyngeal washings and three of stools were positive.

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771. Horstmann, D. M.; Melnick, J. L., and Wenner, H. A. Isolation of Poliomyelitis Virus from Human Extra-Neural Sources: Comparison of Virus Content of Pharyngeal Swabs, Oropharyngeal Washings and Stools of Patients, J. Clin. Investigation **25**:270-274 (March) 1946.

772. Melnick, J. L.; Horstmann, D. M., and Ward, R.: Isolation of Poliomyelitis Virus from Human Extra-Neural Sources: Comparison of Content of Blood, Oropharyngeal Washings and Stools of Contact, J. Clin. Investigation **25**: 275-277 (March) 1946.

In another study the same authors [773] demonstrated virus in stools in 70 per cent of 61 cases in the first two weeks after onset, in 50 per cent in the third and fourth weeks, in 27 per cent in the fifth and sixth weeks and in 13 per cent in the seventh and eighth week; in 1 instance, virus was present during the twelfth week after onset. No virus was obtained in 23 specimens collected from the thirteenth to the twenty-fourth week. Whether the patients were paralytic or not made no difference in the presence of virus.

In a third article, Ward, Horstmann and Melnick [774] report the results of blood tests on 111 patients with poliomyelitis, made in the light of more recent methods of purification; only 1 test gave positive results.

PATHOLOGY AND PHYSIOLOGY

Fischer,[775] in a study of the function of the spinal cord and poliomyelitis, states that lesions appear everywhere in the central nervous system, though usually in the motor systems; lesions of the cord are commonest in the internuncial areas. A lack of correlation between symptoms and actual damage is pointed out. Only two groups reported results of research on early changes in muscles. Fischer states the opinion that of all the concepts of Sister Kenny that of spasm seems to be the most acceptable. He concludes:

> The problems of muscle function in poliomyelitis are further complicated by the fact that as a rule not all motor units of an anatomic muscle are involved in the same way and to the same extent by all the possible mechanisms outlined. Nevertheless, present knowledge of the physiology of the central nervous system and of the nature of distribution of the lesions in poliomyelitis permits one to visualize some of the probable mechanisms involved in the causation of the observed symptoms. Since the internuncial neurons, which are of such importance according to the newer physiologic concepts, are not always at the same spinal cord levels as the anterior horn cells connected with the affected muscles, it becomes understandable why often the level of damage in the spinal cord does not correspond to the level from which the motor nerves originate.

The pattern of distribution of the histologic lesions of poliomyelitis was studied by Luhan [776] in 13 fatal cases which were predominantly instances of the "bulbar" type of the disease. The cases occurred in

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773. Horstmann, D. M.; Ward, R., and Melnick, J. L.: Isolation of Poliomyelitis Virus from Human Extra-Neural Sources: Persistence in Stools After Acute Infection, J. Clin. Investigation **25**:278-283 (March) 1946.

774. Ward, R.; Horstmann, D. M., and Melnick, J. L.: Isolation of Poliomyelitis Virus from Human Extra-Neural Sources: Search for Virus in Blood of Patients, J. Clin. Investigation **25**:284-286 (March) 1946.

775. Fischer, E.: Modern Physiologic Concepts of Spinal Cord Function and Poliomyelitis, Arch. Phys. Med. **27**:333-338 (June) 1946.

776. Luhan, J. A.: Epidemic Poliomyelitis, Arch. Path. **42**:245-260 (Sept.) 1946.

the Chicago epidemic of 1943. Involvement of the gigantocellular layer of the motor cortex was noted in 12 of the 13 cases. This observation is in conformity with the findings in several previous investigations and is evidence of the presence of a systemic factor in poliomyelitis. The observation is also a clue to the identification of the virus, so far as identification may be ventured from the exhibition of pathologic changes in the central nervous system. The olfactory route was probably not the important channel of inoculation in these cases. The author notes that certain caprices of histologic reactions may be encountered in human poliomyelitis.

Watson and others [777] state that the white matter of the central nervous system of warm-blooded animals contains small amounts of coproporphyrin. Occasionally hypertension occurs in acute porphyria, which commonly affects the central nervous system. The authors studied 64 cases of poliomyelitis. They state:

> A considerable excess in the excretion of coproporphyrin III has been commonly noted in a series of urine samples from cases of acute poliomyelitis. The total urinary coproporphyrin is usually in the range of 100-500 γ per 24-hour sample, with from 50-90% of Type III isomer, as compared with 20-100 γ and 8-35%, normally.

Carey and others [778] conclude:

> One factor in the atrophy of disuse of muscle appeared . . . to be the substantial loss of the discharge of neurosomes into muscles as well as the quantitative decrease of the myoplasm. The giant fusiform neurosomes that appear during the early period following tenotomy disappear when the living muscle *in situ* is adequately restretched prior to excision and gold implantation.

Melnick and Horstmann [779] found that a specific strain of poliomyelitis virus, when administered subcutaneously or orally to chimpanzees, caused a subclinical infection of the gastrointestinal tract lasting about two weeks and that neutralizing antibodies appeared subsequently in the serum.

A second experiment showed that the immunity following the infection was sufficient to prevent the presence of the virus in feces after the subcutaneous injection of similar strains three months later.

Another experiment showed that when the animals had had one infection their subsequent immunity was such that on feeding the

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777. Watson, C. J.; Schulze, W.; Hawkinson, V., and Baker, A. B.: Coproporphyrinuria in Acute Poliomyelitis, Proc. Soc. Exper. Biol. & Med. **64:** 73-78 (Jan.) 1947.

778. Carey, E. J.; Haushalter, E.; Massopust, L. C.; Garofalo, F.; Lynch, J.; Tabat, D., and Socoloff, E.: Effects of Use and Disuse on Nerve Endings, Neurosomes and Fiber Types in Skeletal Muscle, Proc. Soc. Exper. Biol. & Med. **64:**193-200 (Feb.) 1947.

779. Melnick, J. L., and Horstmann, D. M.: Active Immunity to Poliomyelitis in Chimpanzees Following Subclinical Infection, J. Exper. Med. **85:**287-303 (March 1) 1947.

similar strain orally, virus was recovered from the feces for a period of only two days, whereas after the first administration the virus had been recovered over a two week period.

The authors state:

This report is concerned with the production of subclinical poliomyelitis in the chimpanzee, and immunity to such infection. Subclinical infection was produced in eight chimpanzees by the administration of virus orally or intracutaneously, and was measured by the production of a virus carrier state and the development of neutralizing antibodies. Immunity was tested by attempting to induce the carrier state again by a challenge dose of virus by the same routes.

With an homologous strain as the challenge virus, immunity as defined here was produced in each of four chimpanzees tested. Neutralizing antibodies to the homologous strain were present about 1 month following the first exposure to virus by either the oral or cutaneous route.

In another group of two chimpanzees, one developed neutralizing antibodies and immunity to heterologous strains, and one did not.

Bodian and Howe [780] state that no correlation could be made between lesions of the peripheral ganglions in infected and noninfected chimpanzees. In serial sections in fatal cases in human beings there were no significant lesions in stellate or celiac ganglions, but in trigeminal and spinal sensory ganglions there were both neuronal and infiltrative lesions, suggesting a spread of virus centrifugally from the central nervous system. The authors state the belief that it is doubtful that lesions in sympathetic ganglions are specifically due to poliomyelitis.

The authors conclude:

This hypothesis, which we have previously presented and discussed, is that the V, VII, and IX cranial nerves, serving the oropharynx, and the X cranial nerve supplying the lower alimentary tract are the most likely routes of passage of virus to CNS, according to the present state of our knowledge. The mucous membranes supplied by these nerves, moreover, are the only ones shown regularly to contain virus in man.

Two principal difficulties in the interpretation of histopathological findings in peripheral ganglia were revealed by this study. The first is that the specificity of lesions in sympathetic ganglia had not been established beyond doubt as being due to poliomyelitis. The second is that the presence of characteristic lesions in sensory ganglia does not, and cannot, reveal whether the virus reached the ganglia from the periphery or from the central nervous system, except in very early preparalytic stages or in exceptional cases of early arrest of virus spread and of lesion production.

Hodes [781] demonstrates associated peripheral nerve defects in poliomyelitis. The author states the belief that the concepts of pathology

780. Bodian, D., and Howe, H. A.: The Significance of Lesions in Peripheral Ganglia in Chimpanzee and in Human Poliomyelitis, J. Exper. Med. **85**:231-242 (March 1) 1947.

781. Hodes, R.: Electromyographic Studies of Human Poliomyelitis, Am. J. M. Sc. **213**:509-510 (April) 1947.

must be broadened to include both peripheral and central nervous system structures, and especially structures that have anything to do with movement.

Luft and Müller [782] examined 66 persons, 54 of whom had acute poliomyelitis during 1944 and 1945, and 12, during the period of 1934 to 1936; endocrine disorders were observed in 20 of these patients, all of whom were women. The endocrine disorders varied to a large extent; there were menstrual disorders in 8 patients, changes of body weight in 11, disturbances of sexual and bodily development in 3 and increased thirst in 3. Decreased dextrose tolerance was demonstrated in 14 cases in which tests were performed. Hypertrichosis was present in 24 cases; it was most common in those in which there was pronounced paresis of the extremities. In several cases, the hypertrichosis was probably a manifestation of a trophic disorder following the injury of the peripheral neuron. Mental disorders were observed in 36 of the 66 patients. Those who had poliomyelitis as adults showed mental disorders of the organic neurasthenic type. In 4 of the 7 patients who had the disease during childhood, a change of personality was noticed. The frequency of mental disorders was equal in children and in adults.

Physical invalidity was of little importance in the development of mental disorders. There was no correlation between clinical signs of encephalitis during the acute stage of poliomyelitis and the appearance of endocrine or mental disorders in the after-stage. Endocrine and mental disorders appeared independently of each other. The pathologico-anatomic basis of the endocrine and mental disorders is obscure; they may be considered as manifestations of inflammatory changes in the hypothalamus.

Robinson [783] states the theory that pressure from edema produces spasm, pain and paralysis and that most patients with high temperature have involvement of the thermal center; general dehydration presents a logical early treatment for relief.

Holtman [784] states that seasonal temperature fluctuations and resulting metabolic disturbances, particularly a decrease in metabolic rate, may be considered as being more conducive to susceptibility than prolonged exposures to relatively high, yet stable, temperatures.

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782. Luft, R., and Müller, R.: Endocrine and Mental Disorders in Acute Anterior Poliomyelitis, Acta med. Scandinav. **127**:448-450 (May 10) 1947.

783. Robinson, T. E.: Poliomyelitis: Observations on Etiology, Pathology and Symptomatology, Rocky Mountain M. J. **43**:119-123 (Feb.) 1946.

784. Holtman, D. F.: Effect of Environmental Temperature on Mouse Susceptibility to Poliomyelitis Virus, Science **103**:137-138 (Feb. 1) 1946.

Bodian [785] notes that muscular rigidity, associated with hyperflexion, often precedes flaccid paralysis. [ED. NOTE.—The only fault with this statement is that the phenomenon is not a clinical fact.] The so-called muscle spasticity is a phenomenon occurring with increased stretch reflexes, but one which occurs late, or relatively so, and may not occur at all. Tremor is mentioned; it is not a common factor in clinical poliomyelitis, though fasciculation is. Material from three specimens was injected intracerebrally into experimental animals; since the animals showed spasticity in the legs without the presence of lesions in the lumbar portion of the cord, it is concluded that lesions in the brain alone can produce the spasticity of acute poliomyelitis.

Flynn [786] describes the clinical course of the disease and the autopsy record in the case of a man of 25 who died of poliomyelitis. Of interest is the photograph showing severe atrophy of degeneration.

TREATMENT

Nelson [787] relates all factors to be considered in evaluating effective treatment in poliomyelitis. The author notes that when cases are to be compared the points of examination in the course of illness should be the same and that when percentage of improvement is to be calculated patients must of necessity have been ill for about equal lengths of time. He also states that comparisons between two groups of patients should be made only on corresponding muscles with similar degrees of involvement. Fallacies creep in when different groups of muscles are compared. Unless such factors are taken into consideration, a treatment which has no effect on the paralysis of poliomyelitis may appear to yield remarkable results when administered to patients with mild degrees of paralysis early in the disease, whereas the application of the same treatment to the same patients later in the disease, or to patients with severe paralysis, may appear actually to do harm; in neither case would the true picture be obtained.

Buchanan and his associates [788] describe a simplified program that could be established in any general hospital. The paper should be consulted for details.

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785. Bodian, D.: Experimental Evidence on Cerebral Origin of Muscle Spasticity in Acute Poliomyelitis, Proc. Soc. Exper. Biol. & Med. **61**:170-175 (Feb.) 1946.

786. Flynn, J. E.: Sudden Death During Clinically Convalescent Stage of Anterior Poliomyelitis, J. Iowa M. Soc. **36**:103-105 (March) 1946.

787. Nelson, N. B.: Factors to Be Considered in Evaluating Effect of Treatment in Anterior Poliomyelitis with Special Reference to Improvement in Muscle Strength, Arch. Phys. Med. **28**:358-363 (June) 1947.

788. Buchanan, J. J.; Hirt, S., and Wrisley, F.: A Poliomyelitis Program in a General Hospital, Arch. Phys. Med. **28**:289-294 (May) 1947.

Lichstein and others [789] studied the influence of pyridoxine, inositol and biotin deficiencies on the effect of poliomyelitis in over 1,400 mice but could find no striking difference in susceptibility to either Lansing's strain of poliomyelitis or Theiler's strain of encephalomyelitis; neither was there any effect when the animals were fed optimal amounts of these vitamins.

3395 Scranton Road.

XVIII. NEUROMUSCULAR DISORDERS EXCLUSIVE OF POLIOMYELITIS

Prepared by
WINTHROP M. PHELPS, M.D.
BALTIMORE
AND
ROBERT A. KNIGHT, M.D.
MEMPHIS, TENN.

Cerebral Palsy.—The literature reviewed for the year 1946 on the subject of cerebral palsy, though revealing an increasing interest in the treatment of this condition, fails to disclose any particularly new or promising departures from the usual approaches to the problem. It is encouraging that the trend is away from the surgical forms of treatment and toward a more rational routine of muscular reeducation, augmented, when necessary, by judicious and carefully planned surgical intervention. It is important for all who deal with this condition to realize that there is no one method of treatment which can be employed to the exclusion of the others and that no single program of treatment can be employed in all cases of cerebral palsy. The interested surgeon is referred to Phelps's paper,[790] in which the incidence and distribution of cases as to locality and economic level are given and the underlying etiologic factors, the indications for rehabilitation and surgery and the use of drugs are discussed.

[Ed. Note (W. M. P.).—Certain favorable impressions in regard to the value of neostigmine U. S. P. (prostigmin methylsulfate®) in the treatment of cerebral palsy, as recorded in this paper, have, unfortunately, not been substantiated by further clinical trial. Neostigmine is now employed by the reviewer only in certain cases of rigidity and true spasticity, and the results even in these carefully selected cases have, in the main, been disappointing.]

789. Lichstein, H. D., and others: Influence of Pyridoxine, Inositol and Biotin on Susceptibility of Swiss Mice, Proc. Soc. Exper. Biol. & Med. **60**:279-284 (Nov.) 1945.

790. Phelps, W. M.: Recent Significant Trends in Care of Cerebral Palsy, South. M. J. **39**:132-138 (Feb.) 1946.

Fay,[791] in a paper on rehabilitation of movement in patients with cerebral palsy, discusses the necessity for a complete evaluation of the condition of a child with cerebral palsy at the beginning of treatment. This procedure should include a complete neurologic, orthopedic and mental study, and should permit concentration on practically obtainable goals, with the curtailment of useless treatment. Fay briefly describes his approach to rehabilitation with physical therapy from a phylogenetic standpoint, which is in contrast to Phelps's ontogenetic approach.

[ED. NOTE.—Fay, a neurosurgeon, has developed a novel and valuable approach to the problems of cerebral palsy and the treatment of the various manifestations of this condition. It is hoped that a more detailed exposition of this approach will be made available in the literature in the near future.]

In another paper,[792] Fay describes the "high spinal spastic" condition in which the lesion is located at the level of the decussation of the pyramids and is usually the result of birth trauma. This condition must be differentiated from the "cerebral spastic" type and when diagnosed early may be partially or completely relieved by surgical decompression of the posterior ring of the atlas and axis. The author also discusses briefly the physical rehabilitation of the patient with cerebral palsy.

[ED. NOTE.—This paper is an excellent, though brief, discussion of a type of spastic palsy which is rarely differentiated from the true cerebral palsy.]

Denhoff,[793] Evans,[794] Collis and Buck,[795] Dowd,[796] House and Zeiter[797] and House and Martiny[798] have written papers of a general nature, which briefly discuss various phases of the problem of cerebral palsy, such as classification, diagnosis, treatment and the requirements for a training program for the patients. These papers, though excellent

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791. Fay, T.: Observations on Rehabilitation of Movement in Cerebral Palsy Problems, West Virginia M. J. **42**:77-80 (April) 1946.

792. Fay, T.: Problems of Rehabilitation in Patients with Cerebral Palsy, Delaware State M. J. **18**:57-60 (March) 1946.

793. Denhoff, E.: Progress in Cerebral Palsy, Rhode Island M. J. **29**:505-509 (July) 1946.

794. Evans, E. S.: Cerebral Palsy, Proc. Roy. Soc. Med. **39**:317-320 (April) 1946.

795. Collis, E., and Buck, M. C.: Treatment of Cerebral Palsy, J. Ment. Sc. **92**:421-424 (April) 1946.

796. Dowd, H. L.: There Is Hope for Victim of Cerebral Palsy, New York Med. **2**:21-22 (April 20) 1946.

797. House, F. B., and Zeiter, W. J.: Treatment of Cerebral Palsy, Cleveland Clin. Quart. **13**:213-217 (Oct.) 1946.

798. House, F. B., and Martiny, R. J.: Occupational Therapy in Treatment of Congenital Athetosis, Cleveland Clin. Quart. **13**:218-220 (Oct.) 1946.

summaries, contribute little that is new to knowledge of the problem. Usher,[799] in a short paper, considers the social aspects of the problem of the child with cerebral palsy, such as his attitude toward others and toward himself, as well as the proper attitude of the parent toward the child.

[Ed. Note.—This is an excellent, though brief, discussion of a neglected phase of the problem.]

McIntyre[800] reports the results of a study of 287 children with cerebral palsy, with regard to the distribution of their physical handicap in correlation with their mental capacity. He observed that the incidence of mental defectiveness among patients with right hemiplegia was approximately twice as great as that among those with left spastic hemiplegia, and that among patients with quadriplegia mental defectiveness was twice as common in those whose handicap was greater on the right side than on the left.

[Ed. Note.—This study brings out that mental retardation amounting to borderline intelligence or to feeblemindedness occurs more frequently when the handicap is present only on the right side or is more pronounced on that side. The evidence indirectly corroborates Phelps's finding regarding both laterality of cerebral function and the relations of handedness, speech development and localization of cerebral lesions.]

Kabat and Jones[801] review the literature in regard to the effects of neostigmine in the treatment of various neuromuscular disturbances, including poliomyelitis, hemiplegia and spastic cerebral palsy.

They report the results observed in 32 cases of chronic spastic paralysis and related conditions due to cerebral lesions. At the time neostigmine therapy was begun, all other types of treatment for the paralysis were discontinued. The dose of the injections varied from 1 cc. of a 1:2,000 solution of neostigmine methylsulfate U. S. P. (0.5 mg.) with $\frac{1}{200}$ grain (0.32 mg.) of atropine sulfate U. S. P. to 3 cc. of 1:2,000 solution of neostigmine methylsulfate (1.5 mg.) with $\frac{1}{100}$ grain (0.65 mg.) of atropine sulfate; the injections were given six times a week (once daily, excluding Sunday). In a few cases, neostigmine bromide U. S. P. was given orally to supplement the injections, in a dosage of 15 mg. three times per day (45 mg.) with $\frac{1}{150}$ grain (0.4 mg.) of atropine sulfate at the same time. In 11 cases of hemi-

799. Usher, E.: Integrated Approach to Cerebral Palsy, Delaware State M. J. **18**:196-199 (Sept.) 1946.

800. McIntire, J. T.: Incidence of Feeble-Mindedness in the Cerebral Palsied, Am. J. Ment. Deficiency **50**:491-494 (April) 1946.

801. Kabat, H., and Jones, C. W.: Studies on Neuromuscular Dysfunction: Neostigmine Therapy of Chronic Spastic Paralysis from Cerebral Lesions, J. Nerv. & Ment. Dis. **103**:107-129 (Feb.) 1946.

plegia of more than one year's duration, all patients showed definite improvement, the duration of the paralysis appearing not to influence the response. In these cases the improvement consisted in (1) decrease in spasticity, (2) facilitation of voluntary motion and (3) facilitation of sensory function. Kabat acknowledges that the most that can be expected from neostigmine therapy is the facilitation of formation of new pathways through the remaining undamaged portion of the central nervous system. In 8 cases of hemiplegia of less than one year's duration, the response was varied. Of those patients with the spastic type of cerebral palsy, 3 children showed significant improvement, 1 adult slight improvement and 2 adults no improvement. Three adults with the athetoid type of cerebral palsy showed significant improvement, as did 2 children with the ataxic type. Patients with miscellaneous conditions, including acoustic neuroma, anastomosia of the spinal accessory nerve, cervical disk, injury to the spinal cord and pseudothrophic muscular dystrophy, showed little or no improvement.

In a series of 25 patients with cerebral palsy, Jepson [802] reports encouraging results with the use of neostigmine combined with intensive reeducational physical therapy. The younger the patient at the time drug therapy was begun, the more likely was neostigmine to produce beneficial results. Jepson states that he prefers small doses, given more frequently during the day, to larger, less frequently administered doses. It is his opinion that the drug should be administered for at least six months, for if it is discontinued at the end of two or three months there is a partial recurrence of the former spastic symptoms.

Pohl [803] reports on a series of 10 children with cerebral palsy, some of whom had the true spastic form and some the athetoid form of the condition, to whom neostigmine was administered for a period of six months; 8 of the children had been under physical treatment for several years prior to the study. In none of the 10 children was there objective evidence of improvement which could be attributed to the drug, though 3 patients stated that they felt more relaxed during the period of medication.

[ED. NOTE.—My experience with a large number of patients with cerebral palsy has not verified the enthusiastic results of Kabat and Jones [801] and of Jepson.[802] It has been my experience that the use of neostigmine has not effectively facilitated the training-in of motor patterns over undamaged nerve pathways to any appreciable extent.

802. Jepson, P. N.: Use of Prostigmin in Management of Infantile Cerebral Paralysis, J. Pediat. **28**:65-68 (Jan.) 1946.

803. Pohl, J. F.: Effect of Prostigmin in Cerebral Palsy, Minnesota Med. **29**:419-422 (May) 1946.

It is essential, if the effectiveness of the drug is to be accurately determined, that a valid system of controls be instituted, including a period of muscular reeducation and training prior to administration of the drug, during which graphs of the patient's progress are maintained; it is also of importance to determine whether the progress of the patient is maintained at an accelerated rate after discontinuance of the neostigmine. Obviously, it is impossible to use separate patients as controls, since the rate of progress is different for each individual patient. I, too, have noted that some patients feel more relaxed during the period of medication, particularly in regard to the "small muscles," such as those of the hands and the tongue.]

Seidler,[804] in a short paper, discusses Stoeffel's selective resection of the peripheral nerve fibers to the flexor carpi radialis and the pronator teres, the intrapelvic resection of the obturator nerve for spasticity and deformity of the adductor muscles and resection of the branches of the popliteal nerve to the gastrocnemius muscle, both in conjunction with lengthening of the hamstring tendons and alone. Lengthening of the achilles tendon or fasciotomy of the gastrocnemius muscle should not be performed at the same time as the resection of the nerve, since lengthening of the tendon impairs the excursion of the joint and the gait in proportion to the degree of lengthening.

[ED. NOTE.—Before neurectomy or tendon lengthening is performed, it is essential that the status of the antagonists be accurately determined. For example, if there is any degree of spasticity of the dorsiflexors of the foot or ankle, popliteal neurectomy or lengthening of the achilles tendon may well result in a secondary deformity of the calcaneus.]

De Lange[805] discusses dystonia musculorum progressiva in a thorough fashion. This puzzling and relentlessly progressive condition is, fortunately, rather uncommon, but it is an entity which should be kept in mind so that it may be diagnosed early in the course of its development. Curman[806] discusses briefly the various aspects of this disease; in addition, Wilson's progressive lenticular degeneration is considered.

Paraplegia.—As a result of experiences in World War II, there are now appearing an increasing number of papers which deal with the various aspects of the rehabilitation of patients paralyzed as a result of injuries to the spinal cord. The methods of therapy are undergoing radical changes and include care of decubitus ulcers, and treatment of

804. Seidler, F.: Treatment of Spastic Paralysis with Special Reference to Nerve Resection, M. Times, New York **73**:315-316 (Nov.) 1945.

805. Lange, C., De: Dystonia Musculorum Progressiva (Torsion Dystonia), Ann. paediat. **164**:169-181, 1945.

806. Curman, H.: Dystonia Lenticularis (Double Athetosis, Torsion Spasm, Wilson's Pseudosclerosis), Nord. med. (Hygiea) **16**:3468-3471 (Dec.) 1942.

troublesome reflexes and spasticity, infection of the urinary tract and intractible pain.

Poer [807] outlines the treatment and rehabilitative program which has been developed for patients paralyzed as a result of injuries to the spinal cord sustained in World War II. 1. The phase of initial and early therapy includes treatment on the battlefield, transportation and early definitive treatment. Adequate nutrition is supplied, and suprapubic cystotomy is performed if the patient is not voiding. 2. The phase of corrective treatment begins on the patient's arrival at a neurologic surgery center, where all services concerned with the care of these patients are coordinated under a director. Malnutrition, decubitus ulcers and infection of the urinary tract are corrected; foreign bodies at the site of the injury are removed, and if intractible pain, troublesome reflexes and spasticity are present, appropriate neurosurgical procedures are carried out. Any associated injuries, such as fractures or open colostomy wounds, are also cared for. A well planned educational, recreational and prevocational training program is coordinated with the treatment. 3. The phase of ambulation and economic security begins on completion of phase 2. In this period any necessary reconstructive orthopedic measures, such as procedures to provide stabilization of joints or restoration of motion, are carried out. Exercises to strengthen the muscles of the trunk and upper extremities, training in the use of braces, crutches and special walking devices and vocational training are given. It is of interest that approximately 2,500 injuries to the spinal cord occurred in World War II among Army and Navy combat troops. The mortality rate fell from an all-time high of 95 per cent in the Balkan Wars to approximately 20 per cent in World War II.

E. C. Elkins,[808] in a lucid, brief discussion with an appended case report, describes the physical rehabilitation of a paraplegic patient, especially with regard to the reeducation of the muscles of the back, abdomen and upper extremities, the use of crutches and the type of crutch gait to be employed.

Covalt [809] outlines the comprehensive program being developed by the Veterans Administration for the rehabilitation of the veteran with a severe injury to the spinal cord.

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807. Poer, D. H.: Newer Concepts in Treatment of Paralyzed Patients Due to War-Time Injuries of Spinal Cord: Outline of Plan and Statistical Analysis, Ann. Surg. **123**:510-515 (April) 1946.

808. Elkins, E. C.: Physical Rehabilitation After Injury to Spinal Cord: Report of Case with Details of Procedures, Proc. Staff Meet., Mayo Clin. **21**:97-101 (March 6) 1946.

809. Covalt, D. A.: Rehabilitation of Veteran with Severe Spinal Cord Injury: Modern Medical Triumph! Occup. Therapy **25**:197-190 (Oct.) 1946.

Botterell and others [810] describe briefly the treatment of the paraplegic patient with a stable spinal column, including the management of the bladder, decubitus ulcers, pain and mass spinal reflexes. The braces which are of value in enabling these patients to walk are briefly discussed.

[ED. NOTE.—This paper outlines the problem concisely but contains insufficient detail about the various phases of treatment.]

Green [811] and Guttmann [812] also outline and discuss the care and rehabilitation of the paraplegic patient.

Harper [812a] discusses the care of paralyzed patients from the nutritional standpoint. Measures for correction of hypoproteinemia and vitamin deficiency, which are usually present in the paraplegic patient, are outlined, and it is pointed out that a sound nutritional plan must be included if the surgical and medical management of these patients is to be successful.

[ED. NOTE.—This discussion is excellent, though brief.]

According to C. W. Elkins and Wegner,[813] the most frequent neurosurgical problems in their experience in cases of paraplegia in World War II are those of retained foreign bodies in close proximity to the spinal cord or the peripheral nerve roots, intractible pain and uncontrolled spinal reflexes. Indications for removal of retained foreign bodies are: (1) intractible pain; (2) the presence of a foreign body either in, or in close approximation to, the cauda equina; (3) the presence of an intraspinal foreign body in any location (to prevent further formation of scar tissue), and (4) a persistent draining sinus. For the relief of pain, lysis of scar tissue my be indicated if the patient's condition will permit such a procedure. If the patient cannot tolerate such a procedure, spinothalamic chordotomy is effective. Subarachnoid spinal injections of alcohol are not advocated, because of the danger of upsetting an already precarious functioning of the bladder. Uncontrolled spinal reflexes vary in extent and degree, from simple flexion of a limb to the characteristic mass or spinal reflex. Conservative

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810. Botterell, E. H.; Jousee, A. T.; Aberhart, C., and Cluff, J. W.: Paraplegia Following War, Canad. M. A. J. **55**:249-259 (Sept.) 1946; Cincinnati J. Med. **27**:595-623 (Sept.) 1946.

811. Green, P.: Outline of Care of Paraplegic Patient, Manitoba M. Rev. **26**:506-509 (Sept.) 1946.

812. Guttmann, L.: Rehabilitation After Injuries to Spinal Cord and Cauda Equina, Brit. J. Phys. Med. **9**:130-137 (Sept.-Oct.) 1946.

812a. Harper, H. A.: Nutritional Aspects of Care of Paralyzed Patients, Bull. U. S. Army M. Dept. **5**:63-67 (Jan.) 1946.

813. Elkins, C. W., and Wegner, W. R.: Newer Concept in Treatment of Paralyzed Patient Due to War-Time Injuries of Spine: Neurosurgical Complications, Ann. Surg. **123**:516-522 (April) 1946.

treatment, consisting of splinting, bracing and physical therapy, should be employed early, with attention to the prevention of deformity. The administration of curare in moderate doses is helpful in conjunction with the other conservative measures. Later, if necessary, neurectomy of the nerve supply to the adductor muscles may be employed if there is a disabling "scissors" deformity of the legs, preventing walking with braces. If severe spasms of the flexors or extensor muscles persist in the patient with a complete lesion of the spinal cord, the anterior rhizotomy of Munro will produce flaccidity in the legs. Since a given reflex state is not necessarily fixed and some patients show a gradual reduction of the uncontrolled activity, even to partial flaccidity, radical neurosurgical procedures should not be employed early.

James and Braden [814] report the results of the use of curare in the treatment of 12 patients with paraplegia secondary to transverse myelitis, as the result of wounds. Dosage and precautions are discussed, and the authors note that spasticity diminished in every patient for one to two or more hours after every administration of an effective dose. The spasticity gradually returned to its original severity in from four to seven hours after injection; in no instance did the effects of a single administration of curare last more than twenty-four hours. The authors state the belief that the reduction of spasticity, though transient, was an aid in nursing care and physical therapy promoted healing and facilitated skin grafting of decubitus ulcers, and enabled patients to obtain rest at night; in 2 cases, for reasons unexplained, pain was relieved. The authors concur in the opinion of other writers that spastic muscles are affected by curarization with appreciably smaller doses than are innervated muscles.

Ward [815] presents a discussion of para-articular calcification, which may occur in the lower extremities of paraplegic patients. The calcification may be of major degree, though usually it is of minor degree about the knee. The author reports 4 cases, in 1 of which there was extensive para-articular calcification about the knees and one hip, the disorder in the hip being associated with fragmentation of the articular surface of the head of the femur. In discussing the cause of the calcification, it is brought out that the patients had massive edema of the lower extremities at some time after the injury, that the paralysis was usually complete and that there was rapid demineralization of the bones of the lower extremities, associated with hypercalciuria. Repeated minor traumas to the connective tissue structures, with degen-

814. James, D. F., and Braden, S.: Use of Curare in Treatment of Spastic Paralysis, J. Neurosurg. **3**:74-80 (Jan.) 1946.

815. Ward, W. C.: Para-Articular Calcification in the Lower Extremities of Paraplegic Patients, Am. J. Roentgenol. **55**:712-715 (Dec.) 1946; Bull. U. S. Army M. Dept. **6**:771-776 (Dec.) 1946.

erative changes, may result in further attrition and in localized areas of hemorrhage, leading to calcification. Extensive areas of calcification may limit joint motion and interfere with the rehabilitation of the patient. Calcifications about the hip are especially subject to repeated traumas and may eventually become severe enough to limit motion, thus rendering sitting difficult. One patient sustained a fracture of the neck of the femur while turning in bed; when the fracture was recognized several weeks later, extensive calcification and deformity had developed, which prevented the patient from sitting up or beginning the use of braces for ambulation. No treatment is recommended for para-articular calcification or for extensive calcification of soft tissues. Fractures and chipping of articular surfaces may result from too vigorous efforts at rehabilitation.

[ED. NOTE.—This is an interesting paper on a complication seen rather infrequently in civilian practice.]

Emmett [816] describes urologic care in the case reported by Elkins.[808] The suprapubic cystotomy, which was present on the patient's admission, was allowed to close, and a transurethral resection was performed to relieve an obstruction of the vesical neck. After this procedure, vesical function was almost normal. The author describes the physiology of micturition and discusses the indications for transurethral resection in the treatment of disorders of the bladder in patients with paraplegia due to spinal injury.

Deery [817] reviews 23 consecutive cases of Pott's paraplegia in which laminectomy was performed because of failure to respond to conservative measures. Fifteen patients showed a manometric block, and 2 had no block but did have increased protein in the spinal fluid. Of these, 8 (of whom 5 were children) regained the ability to walk well, while 3 improved to the degree that they could walk with varying degrees of difficulty. Ten showed no improvement, and 2 died, 1 of tuberculous meningitis and 1 of generalized tuberculosis. The location for laminectomy was determined by the sensory level present. In all cases the locations of the sensory level, the intraspinal lesion and the apex of the kyphos corresponded very closely. Deery stresses that laminectomy is performed for decompression only, the intraspinal extradural abscesses being aspirated but peridural granulations and ventral compression of the cord by bony ridges being left strictly undisturbed. The laminectomy is made longer and wider than usual, both in those

816. Emmett, J. L.: Transurethral Resection of the Vesical Neck in the Management of Cord Bladder, Proc. Staff Meet., Mayo Clin. **21**:102-107 (March 6) 1946.

817. Deery, E. M.: Laminectomy for Pott's Paraplegia, Ann. Surg. **124**:201-203 (Aug.) 1946.

cases in which fusion has previously been done and in those in which it is to be carried out at the time of laminectomy.

Miscellaneous Neurologic Conditions Involving the Extremities.—Gurdjian and Smathers [818] report a study of 53 cases of injury to peripheral nerves associated with fractures and dislocations of long bones for which operations were performed. The results are discussed, and pertinent papers are reviewed. Numerous drawings, depicting approaches and operative findings, accompany the paper.

Schwartz and Parker [819] relate their experience with early repair of the radial nerve and the humerus in persons with war wounds. They employed secondary débridement, with fixation of the fracture within a five to fourteen day interval after injury; the neurosurgical procedure was carried out three weeks or more after injury. In some cases, at the time of débridement and fixation of the bone, the nerve is approximated with a single silk suture and is surrounded by fibrin film, in order to prevent as much scarring about the nerve as possible until such time as nerve suture can be done. The authors are of the opinion that paralyzed nerves should be visualized at the time of definitive care of the fracture unless there is specific information from the forward hospital giving assurance that the nerve is intact. No end results are given.

In an excellent, fundamentally important paper, Thompson [820] discusses the problem of rehabilitation of the upper and lower extremities after irreparable peripheral nerve injury. The appropriate operative procedures, such as the various tendon transfers and joint stabilizations are discussed as to indications and technic.

Altman and Trott [821] report a modification of Billington's procedure for restoration of the extensor function of the hand and wrist in cases of irreparable lesions of the radial or the dorsal interosseous nerve. In an effort to avoid the sloughing at the angle of the Billington incision and persistent edema of the dorsum of the hand, the authors utilize multiple small incisions and attach the transferred flexor tendons into the extensor and thumb abductor tendons proximal to the dorsal carpal ligament. In most instances of complete paralysis of the radial nerve the tendons of the flexor carpi ulnaris and flexor carpi radialis and the pronator teres muscle are utilized as transfers. In cases of

818. Gurdjian, E. S., and Smathers, H. M.: Peripheral Nerve Injury in Dislocations of Long Bones, Tr. West. S. A. (1944) **52**:496-525, 1945.

819. Schwartz, H. G., and Parker, J. M.: Radial, Early Nerve and Bone Repair in War Wounds, J. Neurosurg. **2**:510-515 (Nov.) 1945.

820. Thompson, T. C.: Orthopedic Measures for Use in Irreparable Nerve Injury, J. Internat. Coll. Surgeons **9**:116-129 (Jan.-Feb.) 1946.

821. Altman, H., and Trott, R. G.: Wrist Drop: Muscle Transplantation for Paralysis of Radial Nerve, J. Bone & Joint Surg. **28**:440-446 (July) 1946.

lesions of the dorsal interosseous nerve, the use of the pronator teres is not necessary. In some instances in this series the palmaris longus was transferred into the tendon of the abductor pullicis longus, as suggested by Bunnell. The authors report having used this procedure in 26 cases, with no failures.

[ED. NOTE.—No personal experience with this technic has been had by the reviewer.]

Pruce [822] describes a simple, easily made splint, designed to prevent the typical hyperextension of the metacarpophalangeal joint of the third and fourth fingers in paralysis of the ulnar nerve. It consists of a soft leather cuff, encircling the proximal phalanges of the third and fourth fingers, and is attached to a wristlet by a rubber band, with the line of pull toward the carpal navicular bone. The splint should be worn until recovery is complete or until it is determined that there is no hope of recovery.

Uflyand and Forshtadt [823] report on pseudoparalysis of the radial nerve due to inhibition of the nerve centers as a result of war wounds of the forearm.

Cannon and Love [824] report 38 cases of tardy palsy of the median nerve, with insidious onset and gradual impairment of function. In 9 of the cases in which operation was done, good results followed section of the transverse carpal ligament and neurolysis. In some patients severe neuritic pain is present, and occasionally trophic ulcers may be observed on the tips of the index and long fingers. This condition may follow a fracture of the wrist after a latent period of many years. The authors stress the importance of distinguishing such lesions of the wrist from lesions of the cervical portion of the spine, protruded cervical disks, the scalenus anticus and cervical rib syndrome, brachial plexus neuritis and progressive muscular atrophy. When the diagnosis is in doubt, roentgenograms of the wrist and cervical portion of the spine should be made routinely.

Jackson [825] has studied the role of galvanism in the treatment of denervated voluntary muscle in man, to determine the effective dose and frequency of treatment and whether any beneficial effect is produced. Ninety-two subjects were studied. She found that for a short period

822. Pruce, A. M.: To Correct Deformity (Claw-Hand) Resulting from Injury to Ulnar Nerve, J. Bone & Joint Surg. **28**:397 (April) 1946.

823. Uflyand, Y. M., and Forshtadt, R. A.: Pseudoparalysis of the Radial Nerve Due to Inhibition of Nerve Centers Following War Wounds of the Forearm, Byull. eksper. biol. i med. **17**:21-23, 1944.

824. Cannon, B. W., and Love, J. G.: Tardy Median Palsy; Median Neuritis; Median Thenar Neuritis Amenable to Surgery, Surgery **20**:210-216 (Aug.) 1946.

825. Jackson, S.: Role of Galvanism in Treatment of Denervated Voluntary Muscle in Man, Brain **68**:300-330 (Dec.) 1945.

after denervation the volume of the part decreases whether or not galvanism is used; when no galvanism is used, wasting continues for about four hundred days and thereafter remains constant, whereas if galvanism is used the rate of wasting is decreased during the first one hundred days and the process ceases thereafter. Galvanism should be used as early as possible after denervation; there should be no break in the continuity of treatment, which should be continued in adequate intensity and frequency and with the effective number of contractions until sufficient voluntary control returns. Galvanism appears to be particularly valuable when immobilization is necessary, the period of denervation is long or the return of independent movements is poor. It is of less importance in children and very active youths.

Jones, LeCompte and Kabat [826] report the use of curare to differentiate the limitation of passive motion of the joints as a result of muscular spasm from that due to organic changes, including intra-articular and extra-articular ankylosis, whether partial or complete. The information is of value in prognosis as well as in outlining treatment. The results obtained in 17 cases are given, some in detail. The number of each of the various types of cases is small, and in some of the cases in which improvement in joint motion was noted after the use of curare the follow-up period is not of sufficient length.

[ED. NOTE.—This is a most interesting and valuable paper and should ing of use in cases of this type, particularly from a differential diagnostic and prognostic standpoint.]

Hollingshead and Markee [827] report the results of a careful anatomic study of cadaver material in regard to multiple innervation of the individual muscles of the extremities. Markee and Löwenbach had previously demonstrated in dogs that multiple nerves entering a muscle may control the contraction of different segments of the muscle. In 1 carefully dissected human cadaver, of 58 separate heads of origin of the long muscles of the limbs all but 15 were entered by nerve branches at more than one point. Ten of these 15 muscles have been observed to receive more than one branch in other cadavers. The multiple branches may enter the muscle close together or may be distributed for some distance over the length of the muscle. Though the physiologic studies have not been carried out on human beings, observations on certain patients with partial paralysis indicate that the same

826. Jones, C. W.; LeCompte, C. B., and Kabat, H.: Studies on Neuromuscular Dysfunction: VIII. Use of Curare to Differentiate Muscle Spasm from Organic Changes in Limitation of Passive Motion at Joints, South. M. J. **39**:799-804 (Oct.) 1946.

827. Hollinshead, W. H., and Markee, J. E.: Multiple Innervation of Limb Muscles in Man, J. Bone & Joint Surg. **28**:721-731 (Oct.) 1946.

phenomenon of segmented contraction occurs. As an example, the authors state that the displacement of the bulge of a muscle on contraction, associated with weakness of the muscle (as seen in certain patients after poliomyelitis), is apparently due to unopposed contraction of a segment of the muscle and stretching of part of the muscle elsewhere.

[ED. NOTE.—This is a most interesting and valuable paper and should be read in its entirety.]

Caldwell and his associates [828] report their experiences with blocking of the stellate ganglion with procaine hydrochloride U. S. P. in a total of approximately 400 cases, comprising a variety of orthopedic conditions. From this number, 78 cases with adequate follow-up observations were studied. Briefly summarized, results were as follows: 1. In 88 per cent of 18 cases of acute subdeltoid bursitis, immediate relief was obtained, though in 50 per cent additional blocks were required, and in 16.7 per cent good results were obtained, though relief was not so dramatic. 2. In 12 cases of periarthritis of the shoulder, the end results were not so striking, but pain was relieved sufficiently to make possible a much more active range of motion for the institution of physical therapy. 3. In 5 cases of myositis and fibrositis of a group of muscles, eventual relief was obtained over a longer period, probably owing to anesthetization of the communicating branches to the fifth and sixth cervical nerves from the middle cervical ganglion. 4. In 8 cases of hypertrophic arthritis of the shoulder, elbow or hand, only transitory relief was obtained, probably because of the irreversible tissue changes already present. 5. In the 5 cases of various types of infectious arthritides, as might have been expected, only temporary relief of pain was obtained. 6. In 17 cases of pain and swelling following fractures and dislocations, blocking of the stellate ganglion was done after reduction of the fractures and dislocations, with pronounced relief of pain and swelling. (The authors now use this procedure almost routinely for patients complaining of pain and tight casts; in many instances it is possible to avoid cutting casts which formerly would have required splitting.) 7. In 8 cases of pain and swelling after trauma (contusions), relief of pain was almost immediate. 8. In 8 cases of post-traumatic causalgia and "fantom pain" after amputation, blocking of the stellate ganglion gave excellent relief from pain and diminution of swelling. In some cases the blocking must be repeated at intervals. The authors describe the two technics that they employ, that of de Sousa Pereira and that of Patzer.

828. Caldwell, G. A.; Borderick, T. F., Jr., and Rose, R. M.: Sympathetic Block of Stellate Ganglion: Application to Orthopedic Conditions, J. Bone & Joint Surg. **28**:513-520 (July) 1946.

Ruskin [829] reports the spectacular relief in 63 cases of various conditions, such as "lumbosacral spasm (sacroiliac)," chronic and Marie-Strümpell arthritis and torticollis. This was achieved by anesthetization of the sphenopalatine ganglion, supplemented by administration of ferrous adenylate (ironyl®) and calcium ascorbate. The author states that the anesthetization of the ganglion is followed by immediate generalized relaxation of spasm of both smooth and striated muscle, as well as of cardiac muscle. He also advocates this treatment for coronary spasm, migraine, renal collic and dysmenorrhea.

[ED. NOTE.—The results reported in this paper should be verified.]

Schumacker [830] discusses the problems in surgical treatment of gangrene in cases of trench foot. Proper emphasis is placed on the value of lumbar sympathetic ganglionectomy in the treatment of the vasoconstriction. The author also discusses treatment of infection of the gangrenous part, amputations, skin grafting and plastic revision of stumps.

[ED. NOTE.—This is an excellent paper and should be read completely.]

Ulmer and Mayfield [831] present a valuable analysis of 75 cases of causalgia from the Percy Jones Hospital. In 88 per cent the injury was proximal to the knee and elbow, and in 60 per cent the burning pain developed within the first forty-eight hours. In all cases the nerve injury was incomplete. The vasomotor alterations were of two types: (1) vasodilatation, with reddish, dry, scaly, warm skin and long, coarse hair, and (2) vasoconstriction, with cold, thin, glistening skin, profuse sweating, loss of hair, tapering of the digits and trophic changes in the nails. Blocking with procaine hydrochloride of the appropriate sympathetic ganglions invariably gave immediate and dramatic relief for one to three hours, and in a few cases partial relief was present for several days; however, no patient obtained complete and permanent relief from the procedure, even when it was repeated. The authors are of the opinion that blocking of the sympathetic ganglions serves two purposes: First, by relieving the pain temporarily, it permits a more accurate evaluation of the nerve injury; second, it establishes the indication for sympathectomy. In the cases in which

829. Ruskin, S. L.: Control of Muscle Spasm and Arthritic Pain Through Sympathetic Block at Nasal (Sphenopalatine) Ganglion and Use of the Adenylic Nucleotide (Ferrous Adenylate): Contributions to Physiology of Muscle Metabolism, Am. J. Digest. Dis. **13**:311-320 (Oct.) 1946.

830. Schumacker, H. B., Jr.: The Surgical Treatment of Gangrene in Trench Foot, Surg., Gync. & Obst. **83**:513-520 (Oct.) 1946.

831. Ulmer, J. L., and Mayfield, F. H.: Causalgia: Study of Seventy-Five Cases, Surg., Gynec. & Obst. **83**:789-796 (Dec.) 1946.

they were employed, neurolysis and periarterial sympathectomy were of no benefit. The pain can be relieved by sympathectomy, which must be complete and must include the injured segment of the nerve; in cases of high sciatic lesions it may be necessary to remove the sympathetic chain as high as the eleventh dorsal ganglion. Ordinarily, the authors employ a preganglionic sympathectomy of the second and third dorsal ganglions in patients with lesions of the upper extremity and removal of the second, third and fourth lumbar ganglions in those with lesions of the lower extremity.

White [832] discusses painful injuries of the peripheral nerves, their surgical treatment and the probable underlying pathologic factors; this is followed with a lucid description of the types of pain, including the pain due to painful neuromas, that of causalgia and that of phantom limb. The various methods of treatment for pain are then considered, and the consensus of the various procedures is given. The following procedures are useless and should no longer be considered: (1) repeated resection of neuromas; (2) neuroclonic treatment or interruption of the nerve trunks at higher levels; (3) reamputation for relief of pain; (4) periarterial sympathectomy; (5) introthecal injections of alcohol and (6) posterior rhizotomy. On the other hand, a single resection of a sensitive neuroma is of distinct value, especially if the hyperesthesia is localized and can be relieved with local infiltration of procaine. Interruption of the sympathetic ganglionic chain, either by repeated chemical blockage with procaine or by sympathectomy, is of great value in patients with the vasomotor and emotional states so frequently noted in these painful conditions. Spinothalamic tractotomy is of value in relieving the pain and tenderness located within the stump itself but is not reliable in relieving phantom pain. Resection of the sensory cerebral cortex has been used successfully in the treatment of phantom limb but is too new a procedure to be completely evaluated. The final approach to the problem of unbearable pain of a phantom limb is the elimination of introspection and self-centered concentration on the condition, which naturally develop as a result of the persistent intractible pain, by the prefrontal leukotomy of Freeman and Watts. This procedure, like postcentral cortical resection, is as yet in the experimental stage and must be further evaluated. Obviously, these procedures are intended for use in cases of the severe and intractible pain in a phantom limb and are indicated as a last resort.

[ED. NOTE.—This, too, is an excellent paper and is deserving of close study.]

832. White, J. C.: Painful Injuries of Nerves and Their Treatment, Am. J. Surg. **72**:468-488 (Sept.) 1946.

Lhermitte and Mouzon [833] report a case in which a lesion of the sciatic nerve was followed by muscular hypertrophy and hyperplastic osseous dystrophy. Alajouanine, Thurel and Houdart [834] report and discuss a case of sciatic paralysis, complicated by an embolic infarction of the buttock and by causalgia, which followed the intragluteal injection of a bismuth salt.

Cole [835] reports 7 cases of maternal obstetric paralysis which occurred in a series of 45,000 deliveries at the woman's clinic of the New York Hospital. Characteristically, the condition exhibits a combination of the following factors: primiparity, prolonged labor, difficult delivery and cephalopelvic disproportion. The pelvis may show a short posterior ilium, a sacral ala with a shallow anterior concavity and a promontory which does not encroach on the posterior pelvic cavity. Clinically, pain during labor referred along the course of the sciatic nerve is the earliest sign and may be overlooked. As labor continues and contractions become more intense, the pain becomes severer and paresthesias may develop. At this time, paralysis and spasmodic contractions of the muscles may develop. In many cases, the condition may not be recognized for several days. The degree of paralysis varies, ranging from drop foot to extensive flaccid paralysis of both lower extremities; it is usually unilateral. The condition is due to trauma of the lumbosacral plexus by the fetal head or, less frequently, by instruments. Prevention depends on recognition of the signs of compression of the lumbosacral cord; a change in method of delivery, e. g., to cesarean section, may be considered. Treatment of the paralysis is conservative, consisting of support of the injured extremity, physical therapy, galvanic stimulation and protection with a brace. The prognosis is guarded, recovery occurring as early as seven to ten days after birth or paralysis clearing up very slowly and incompletely.

Edmunds and Fey [836] present a discussion of the serratus anticus syndrome (isolated paralysis due to neuritis of the long thoracic nerve), with characteristic winging of the scapula. The etiologic features, clinical manifestations and treatment are considered; 2 cases are reported. Passerini [837] reports 2 cases of this condition, while

833. Lhermitte, J., and Mouzon, J.: Muscular Hypertrophy and Hyperplastic Osseous Dystrophy Following a Lesion of the Great Sciatic Nerve and Its Roots, Rev. neurol. **73**:606-608 (Nov.-Dec.) 1941.

834. Alajouanine, T.; Thurel, R., and Houdart, R.: Sciatic Paralysis with Causalgia Associated with Embolic Infarction of Buttock, Due to Intragluteal Injection of Bismuth Salt, Rev. neurol. **78**:58-60 (Jan.-Feb.) 1946.

835. Cole, J. T.: Maternal Obstetric Paralysis, Am. J. Obst. & Gynec. **52**:373-386 (Sept.) 1946.

836. Edmunds, L. H., and Fey, L. D.: Serratus Anticus Syndrome, Clin. Virginia Mason Hosp. **24**:49-52 (June) 1946.

837. Passerini, L.: Report of Two Cases of Paralysis of the Serratus Magnus, Rassegna previd. sociale **12**:10-15 (Dec.) 1940.

Lindqvist [838] reports an instance of this condition due to working with a penumatic drill.

Desirotte [839] discusses "operation table" paralysis, due to faulty positioning of the unconscious patient on the operating table. Unusual positions which may be assumed in association with complete muscular relaxation may result in tension or stretch of the nerves of the brachial plexus. Proper attention to positioning, with adequate precaution, can prevent this complication.

[ED. NOTE.—American readers should again study the paper of Clausen.[840]]

Eaton,[841] in a well written paper, discusses the neurologic causes of pain in the upper extremities. He calls attention to the difficulty and importance of differentiating between neurologic lesions and non-neurologic lesions which give rise to referred pain, such as that from the viscera and the deep-lying somatic structures. The intramedullary lesions of the central nervous system which may give rise to pain in the upper extremities are most frequently syringomyelia and intramedullary tumor of the spinal cord. Root pain may result from rheumatoid spondylitis, hypertrophic spondylitis, ruptured intervertebral disks or extramedullary tumors of the spinal cord. Eaton points out that there are three characteristics of root pain which are of great diagnostic significance: 1. The distribution of the pain is within the segment supplied by a particular nerve root. 2. The pain is frequently intensified by coughing, sneezing and straining; this is the result of increased intraspinal pressure, resulting from blockage of the flow from the intervertebral veins by the increased inthrathoracic and intra-abdominal pressure. Engorgement of the veins of the epidural spaces thus occurs, and this, in turn, either produces pressure on the nerve root directly or stretches the root by displacing the dura toward the spinal cord. 3. The root pain is intensified by stretching of the involved nerve roots. The diagnosis of a ruptured cervical disk is then discussed. Among the syndromes due to lesions of the brachial plexus are those of mechanical compression, including the cervical rib syndrome, the scalenus anticus syndrome, the subcoracoid pectoralis minor syndrome of Wright, the costoclavicular syndrome of Falconer and Weddell and the first thoracic rib syndrome. Nocturnal dyses-

838. Lindqvist, T.: Case of Paralysis of the Serratus Anterior Due to Work with the Pneumatic Drill, Nord. med. (Hygiea) **26**:1163-1164 (June 1) 1945.

839. Desirotte, A.: So-Called "Operation Table" Paralysis, Rev. méd., Liège **1**:101-102 (Aug. 15) 1946.

840. Clausen, E. G.: Postoperative ("Anesthetic") Paralysis of the Brachial Plexus: Review of Literature and Report of Nine Cases, Surgery **12**:933-942 (Dec.) 1942.

841. Eaton, L. M.: Neurologic Causes of Pain in the Upper Extremities, S. Clin. North America **26**:810-833 (Aug.) 1946.

thesia, traumatic lesions of the brachial plexus, tumors, inflammatory lesions and serum neuritis are also considered. Lesions of the peripheral nerves are briefly discussed.

[ED. NOTE.—This paper should be read in *toto* by all orthopedic surgeons.]

Paull [842] reports a case of Wright's subcoracoid pectoralis minor syndrome which was successfully treated by conservative measures, including change of sleeping habits and stretching and reeducation of muscles.

In a paper discussing the results of conservative treatment in a series of cases of "sciatic neuritis," as compared with an analogous series of cases in which a diagnosis of ruptured intervertebral disk had been confirmed by operation, Dunning [843] states that the prognosis for recovery was satisfactory in 54 per cent of the cases of sciatic neuritis, while operation in the cases of ruptured intervertebral disk promptly relieved the pain and bettered the prognosis by 32 per cent. However, it is Dunning's opinion that natural processes should be given an opportunity to repair the defect before spinal operation is urged. The neurologic signs and the protein content of the spinal fluid were not found to be of prognostic value. The author maintains that the symptoms and signs of a ruptured intervertebral disk in the fourth or fifth lumbar intervertebral space are indistinguishable from the well defined syndrome formerly called sciatic neuritis.

Mack [844] reports a case of meralgia paresthetica in which, at the time of operation, it was noted that the lower fibers of the inguinal ligament exerted a compressive and shutter-like action on the lateral femoral cutaneous nerve in its passage over the brim of the pelvis. This, he feels, may be the underlying etiologic factor. He prefers the operation described by Lee for this condition. Graber-Duvernay [845] also reports on meralgia paresthetica.

Ocular Torticollis.—Kennedy [846] reports the case of a 57 year old woman who had "drawing of the neck" of twelve years' duration. It was first thought that she had a spasmodic type of torticollis, and the usual orthopedic measures were used, without relief. Later, it was found that she had a crossed and vertical diplopia, as a result of paralysis

842. Paull, R.: The Neurovascular Syndrome as Manifested in the Upper Extremities, Am. Heart J. **32**:32-38 (July) 1946.

843. Dunning, H. S.: Prognosis in So-Called Sciatic Neuritis, Arch. Neurol. & Psychiat. **55**:573-577 (June) 1946.

844. Mack, E. W.: Meralgia Paresthetica: New Causal Observations, West. J. Surg. **54**:390-391 (Oct.) 1946.

845. Graber-Duvernay, J.: Remarks on Femorocutaneous Neuralgia (Meralgia Paresthetica) Observed at the Center for Displaced Persons in Aix-les-Bains, Rev. du rhum. **13**:97-99 (April) 1946.

846. Kennedy, R. J.: Ocular Torticollis: Report of a Case, Cleveland Clin. Quart. **13**:163-165, 1946.

of the superior rectus muscle on the side of the head tilt, with overaction of the inferior oblique muscle on the opposite side. The differential diagnosis is as follows:

Ocular Torticollis	Spasmodic Torticollis
1. Head tilt not pronounced	1. Obvious head tilt
2. Sternocleidomastoid muscle not actually contracted; slight "tightness" of structures on side of tilt	2. Gross contracture of sternocleidomastoid muscle on side of tilt
3. Head passively straightened, but binocular vision interrupted; diplopia present unless patient "fixes" with one eye only and neglects the image of the other	3. Head tilt cannot be passively corrected
4. Face usually rotated slightly toward side of head tilt; in some cases turned downward	4. Face always rotated away from side of head tilt and turned upward
5. Abnormal conjugate ocular movements present	5. Conjugate ocular movements normal
6. Extraocular muscular imbalance present	6. Extraocular muscular balance normal

The treatment of ocular torticollis consists primarily of shortening or advancing of the affected muscle, orthoptic training and the use of prisms, if necessary. In cases of long standing, when there is apparent hypertrophy of the sternocleidomastoid muscle, an intradural section of the anterior (motor) nerve roots of the first three cervical nerves bilaterally and a section of the spinal accessory nerve on the affected side are indicated.

Degenerative Diseases.—Wechsler and Brody [847] consider the problem of primary lateral sclerosis and its relation to the other scleroses of the spinal cord. They are of the opinion that it is a distinct clinical syndrome, unrelated to the other scleroses. The scleroses are all merely the result of the selective affinity of various endogenous and exogenous noxious agents for specific structures of the nervous system. Neither multiple sclerosis nor amyotrophic lateral sclerosis presents a single etiologic or pathologic entity; each consists of several syndromes, in fairly consistent clinical groups. The authors note that there appears to be an increase in incidence of the more benign types of these degenerative diseases of the nervous system, so that, despite want of knowledge of causes, one may venture a less hopeless prognosis.

Gordon,[848] in an interesting paper, adds 2 pure, or unmixed, cases of primary lateral sclerosis to the literature; these have been followed by him for twenty-four years. He is of the opinion that "subacute degeneration" has a legitimate place in the variety of forms of primary lateral sclerosis, in which there is an absence of spasticity of the

847. Wechsler, I. S., and Brody, S.: Problem of Primary Lateral Sclerosis, J. A. M. A. **130**:1195-1198 (April 27) 1946.

848. Gordon, A.: Clinical Status of Unmixed Types of Primary Lateral Sclerosis After Twenty-Four Years of Observation (Subacute Degeneration), J. Nerv. & Ment. Dis. **103**:378-382 (April) 1946.

musculature of the extremities from the onset and an absence of contracture throughout the course of the disease.

Simmons,[849] in an article dealing with his experiences with curare as an adjunct to general anesthesia and in the treatment of spastic paralysis, reports favorable results in 2 cases of disseminated sclerosis with parkinsonism and in 1 case of "degenerative and idiopathic" Parkinson's disease.

[ED. NOTE.—Because of the small series reported the results are inconclusive.]

Halpern[850] reports a posterior spinal syndrome characterized by (1) sensory ataxia of the legs and (2) loss of vibratory sense in segmental distribution, the remainder of the nervous system is intact. The loss of vibratory sense was located in the sacral and lumbar segments. In all cases the condition cleared up within six weeks. There was no paresis, atrophy or disturbed reflexes in any of the patients; no pain was present on pressure over the nerve trunks or muscles. Halpern reports 6 cases of this condition, which he considers a primary involvement of the posterior portion of the spinal cord, involving the tract of Goll.

Lipson and DeNardi[851] report and discuss 3 cases of Friedreich's ataxia.

DeGennaro[852] discusses the complications and sequelae of syringomyelia, including secondary deformities.

Campailla[853] reports a case of syringomyelobulbia following peripheral trauma of the thigh.

Nosik[854] reports a case of olivopontocerebellar atrophy (heredocerebellar ataxia of Marie) with encephalographic findings.

Planson[855] reports on cases of familial spastic paraplegia.

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849. Simmons, H. J. A.: Preliminary Investigation of the Use of Curare in Anesthetic Practice and for Treatment of Spastic Paralysis, Brit. J. Anaesth. **20**:34-38 (Jan.) 1946.

850. Halpern, L.: Ataxia of Legs and Loss of Vibration: Isolated Spinal Syndrome, J. Nerv. & Ment. Dis. **104**:474-479 (Nov.) 1946.

851. Lipson, H. A., and DeNardi, J. M.: Friedreich's Ataxia (A Familial Hereditary Study of Three Cases), Dis. Nerv. System **7**:261-267 (Sept.) 1946.

852. DeGennaro, R.: The Deformities Following Syringomyelia, Clinica, Bologna **10**:120-131, 1945-1946.

853. Campailla, G.: Syringomyelobulbia Syndrome Following Peripheral Trauma of the Thigh, Gior. med. mil. **93**:311-319 (July-Aug.) 1946.

854. Nosik, W. A.: Olivopontocerebellar Atrophy (Heredocerebellar Ataxia of Marie) with Encephalographic Findings: Report of a Case, Clevleand Clin. Quart. **13**:203-207 (Oct.) 1946.

855. Planson: Familial Spastic Paraplegia, Paris méd. **1**:105-108 (March 9) 1946.

In a detailed study, Charcot-Marie-Tooth disease and the other heredodegenerative diseases are discussed and cases reported by Bancalari Rodriguez.[856]

The Myopathies.—Freeman [857] reports the postmortem findings in 4 cases of amyotonia congenita. The muscles showed the usual paleness and thinness, with underdevelopment. In the nervous system, the ventral roots were thin, pinkish and translucent, while the dorsal nerve roots appeared normal. The brain itself was grossly normal. Microscopic examination of the spinal cord showed a great reduction in the number of the ventral horn cells at all levels, with no indication of degeneration or reaction. The myelin sheaths of the fiber tracts of the spinal cord were small and irregularily grouped. The brain showed thinning of the precentral cortex, with less numerous cellular elements, especially the giant multipolar cells of Betz, which were also abnormal in size and shape. The cortex was immature in regard to cellular arrangement, with a tendency to column orientation. No degenerated cells were seen; rather, they were of an immature type. Some cellular deficiency, though to a less degree, was noted in the postcentral convolutions. Freeman concludes that amyotonia congenita appears to be a disorder in which there is a defective development of the whole motor system, from the precentral gyrus to the muscles. It has its counterpart in amyotrophic lateral sclerosis, in which there is degeneration of the whole motor system from the precentral cortex to the muscles.

Hanhart [858] reports a study of 29 cases of infantile spinal muscular atrophy (Werdnig-Hoffman syndrome) which occurred as simple recessive sublethal mutations in fourteen families.

Matus [859] points out that the primary myopathies, unlike the secondary muscular atrophies, have no apparent neural lesion as a cause. The former all have these distinguishing etiologic and clinical characteristics: 1. They occur in infants and adolescents. 2. They often take on a familial aspect, sometimes being hereditary. 3. The muscles, during the period of atrophy, do not present fibrillary contractions; the small tremors of the muscle fascicles, visible through the skin in patients with myelopathic atrophy, are here conspicuous by their absence. 4.

856. Bancalari Rodriguez, E.: Progressive Amyotrophy of Charcot-Marie-Tooth: A Contribution to the Study of Heredodegenerative Diseases, Rev. neuropsiquiat. **8**:488-546 (Dec.) 1945.

857. Freeman, W.: The Motor Cortex in Amyotonia Congenita, J. Neuropath. & Exper. Neurol. **5**:207-212 (July) 1946.

858. Hanhart, E.: Infantile Progressive Spinal Muscular Atrophy Occurring as a Simple Recessive, Sublethal Mutation, Helvet. paediat. acta **1**:110-133 (Nov.) 1945.

859. Matus, S.: Primary Myopathy Characterized by "Micropygia" in the First Generation and Scapulohumeral Dystrophy in the Second One of Consanguineous Parents, South African M. J. **20**:170-171 (April 13) 1946.

Reaction of degeneration is absent, very early changes in chronaxia indicating a mixture of healthy fibers and pathologic fibers in the affected muscles. 5. The atrophy begins in the big muscles of the shoulder, arm, back and thigh, rather than in the small muscles of the hand. 6. The distribution of the muscular atrophy, once established, is characteristic, the muscles of the distal parts of the extremities being respected while disappearance of the muscles of the thighs and the lumbar region results in a special attitude of the patient and causes deformities. 7. Sometimes the muscles of the face are involved in the progressive atrophy. 8. The muscular atrophy is sometimes accompanied with considerable adiposity of the lower limbs, giving a false appearance of muscular hypertrophy (pseudohypertrophy). 9. The reflexes are not exaggerated, there being no disorder of bulbar origin, such as an accelerated pulse or paralysis of the palate.

Four types of primary myopathies are described: (1) Leyden-Möbius dystrophy; (2) juvenile type (Erb); (3) Landouzy-Dejerine atrophy and (4) pseudohypertrophic type. However, these types cannot be separated into definite groups. The author reports 2 cases, of brothers aged 5 and 6, of the pure scapulohumeral type of atrophy. The father showed micropygia (small buttocks), with fatty adiposity overlying the upper part of the gluteus muscles. He stated that his cousin (his father's brother's daughter) had the same condition. Also, his wife was a cousin, the daughter of another of the father's brothers.

In a paper devoted to differentiation of the primary myopathies, such as progressive muscular dystrophy of the distal, or Gowers', type and the secondary myopathies, such as progressive muscular atrophy, Bowden and Gutmann,[860] of Oxford University, report detailed multiple biopsies in 2 cases. They conclude that advanced atrophy in the muscle fibers, intact large intramuscular nerve trunks and abortive terminal regeneration of the nerve fibers are characteristic features of the muscles in a case of progressive muscular dystrophy, while in the so-called secondary myopathies, such as peroneal muscular atrophy, the nerve trunks may be empty or may contain both normal fibers and empty Schwann tubes; occasionally, they may contain regenerated nerve fibers. The authors advocate muscle biopsy as an aid to diagnosis in unusual cases of muscular atrophy and weakness.

Hafner and others[861] report the results in 9 cases of progressive muscular dystrophy in which treatment was with synthetic *d,l*-alpha-tocopherol acetate (ephynal acetate®), for periods of three to twenty-

860. Bowden, R. E. M., and Gutmann, E.: Observations in a Case of Muscular Dystrophy, with Reference to Diagnostic Significance, Arch. Neurol. & Psychiat. **56**:1-19 (July) 1946.

861. Hafner, P. G.; Anderson, R.; Davis, H., and Chuinard, E. G.: Treatment of Progressive Muscular Dystrophy with Synthetic Di-Alpha-Tocopherol, Northwest Med. **45**:256-258 (April) 1946.

seven months. Four patients showed objective increase in the strength of certain muscle groups, as well as subjective improvement; 2 remained in the same condition, and 3 gradually became weaker, despite treatment. No changes were noted in the urinary excretion of creatine or creatinine. Garces Cuadra and Montes R [862] report their results in the therapy of progressive muscular dystrophy, utilizing alpha-tocopherol.

Fagin [863] reviews the clinical features of dystrophia myotonica and presents 2 cases. One case was that of a female patient with diabetes mellitus and a colloid goiter, suggesting that endocrinopathy may be an important factor, while the second was that of a male patient, with an associated hyperostosis frontalis interna. The author brings out that the latter condition (also known as metabolic craniopathy) is a syndrome with endocrine, metabolic and neurologic changes associated with alterations in the bony structure of the skull and appears to be closely related to pituitary dysfunction.

Weinberg-Heyrouti and Reif [864] report a case of acute dermatomyositis in a child.

Neurogenic arthropathy.—Delano [865] discusses the history of the theories of the etiology and pathogenesis of Charcot's joint. After examining the evidence, the author notes that there is no definite proof of the existence of "trophic" nerves and states the belief that the changes in neurogenic arthropathy are brought about by the occurrence of repeated minor subclinical traumas in an insensitive joint.

Smith [866] describes the osseous changes which may occur in yaws, these ordinarily being not unlike the low grade type of osteomyelitis of the long bones, which becomes quiescent of its own accord. In the spine, erosions, spurs and bony bridges may appear, often closely resembling the changes in hypertrophic arthritis. Patients usually have relatively little pain in proportion to the extensiveness of the bone changes. The author reports a case of yaws in a native of the Marshall Islands, whose bilateral involvement of the knee and ankle was clinically identical to the typical manifestation of Charcot's joint in late syphilis.

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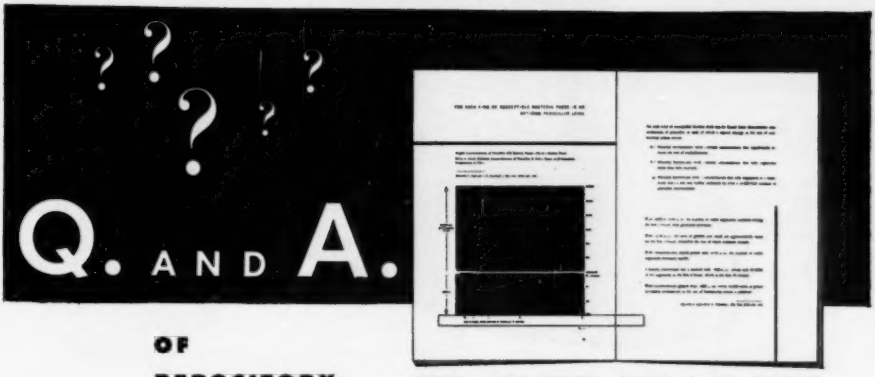
862. Garces Cuadra, H., and Montes R, O.: Alpha-Tocopherol Therapy for Progressive Muscular Dystrophy, Rev. chilena de pediat. **16**:798-811 (Aug.) 1945.

863. Fagin, I. D.: Dystrophia Myotonica: Report of Two Cases with Associated Hyperostosis Frontalis Interna in One, J. Michigan M. Soc. **45**:500-503 (April) 1946.

864. Weinberg-Heyrouti, C., and Reif, L.: Acute Dermatomyositis in a Child, Ann. paediat. **166**:193-202, 1946; addendum, ibid. **167**:215, 1946.

865. Delano, P. J.: Pathogenesis of Charcot's Joint, Am. J. Roentgenol. **56**:189-200 (Aug.) 1946.

866. Smith, F. H.: Charcot-Like Joints in Yaws, U. S. Nav. M. Bull. **46**:1832-1843 (Dec.) 1946.



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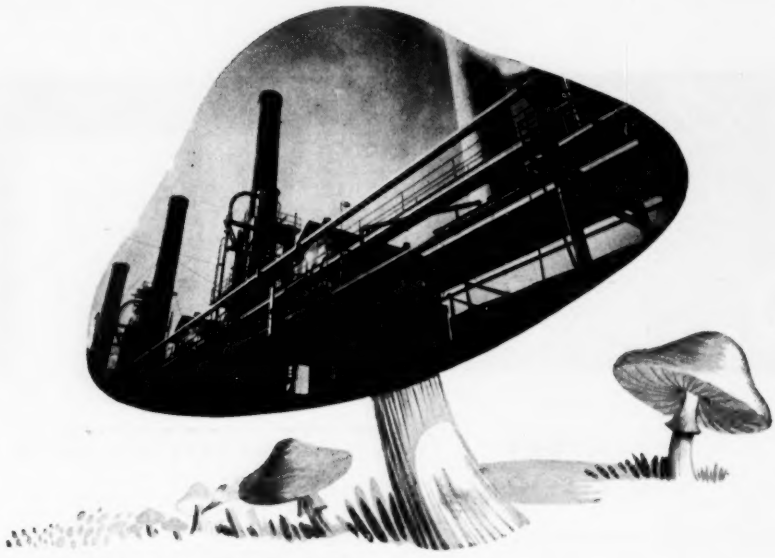

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CONTENTS

PAGE

Retrograde Spread of Carcinoma in the Rectum and Rectosigmoid. JAMES F. CONNELL JR., M.D., AND ANTONIO ROTTINO, M.D., NEW YORK.. 807

Early and Delayed Clinical Effects of Vagotomy for Peptic Ulcer. CHARLES S. KIPEN, M.D., AND G. ARNOLD STEVENS, M.D., BEVERLY HILLS, CALIF. 814

Intravenous Administration of Procaine Hydrochloride for Painful Prolapsed Hemorrhoids. BURNETT SCHAFF, M.D., AND J. GORDON SPENDLOVE, M.D., OTEEN, N. C..... 825

Treatment of Cancer of Breast by Simple Mastectomy and Roentgenotherapy. ROBERT MCWHIRTER, F.R.C.S., F.F.R., EDINBURGH, SCOTLAND 830

Anesthesia in Traumatic Conditions. FRANCIS F. FOLDES, M.D., PITTSBURGH 843

Short Radius. HENRY MILCH, M.D., NEW YORK..... 856

Use of Skin Grafts in Repair of Cleft Palate to Improve Speech. HAMILTON BAXTER, M.D., D.D.S.; JOHN DRUMMOND, M.D., D.D.S., AND MARTIN ENTIN, M.D., MONTREAL, CANADA..... 870

Contusions of the Lung from Nonpenetrating Injuries to the Thorax. W. C. SEALY, M.D., DURHAM, N. C..... 882

Technic for Arthrodesis of the Hip When the Femoral Head and Neck Are Absent. LEON L. WILTSE, M.D., LONG BEACH, CALIF., AND WALTER A. L. THOMPSON, M.D., NEW YORK..... 888

Relief of Chronic Hypertension by Excision of Pheochromocytoma. FREDERICK M. OWENS JR., M.D., CHICAGO..... 896

Drill Perforation, a Simplified Method for Ventricular Puncture. T. C. ERICKSON, M.D., AND H. M. SUCKLE, M.D., MADISON, WIS..... 903

Xanthomatous Giant Cell Tumors Arising in Soft Tissue: Report of an Instance of Malignant Growth. MATHEW W. KOBAK, M.D., AND SAMUEL PERLOW, M.D., CHICAGO..... 909

Granulomas of Large Size Caused by Implantation of Talcum (Talcum Sarcoids). G. E. GRUENFELD, M.D., ST. LOUIS..... 917

Pseudocyst of the Liver: Report of a Case. EDGAR J. POTH, M.D. PH.D., AND A. WILLIAM DELOACH, M.D., GALVESTON, TEXAS..... 925

Islet Cell Tumor of the Pancreas. FREDERICK H. AMENDOLA, M.D., NEW YORK 928

Granulomas of the Ileocecal Region Secondary to Appendicitis (Ligneous Cecitis) Which Simulate Neoplasms. JAMES W. WILSON, M.D.; MALCOLM B. DOCKERTY, M.D.; JOHN M. WAUGH, M.D., AND J. ARNOLD BARGEN, M.D., ROCHESTER, MINN..... 933

Progress in Orthopedic Surgery for 1946. A Review Prepared by an Editorial Board of the American Academy of Orthopaedic Surgeons:

XVII. Infantile Paralysis; Research. J. A. TOOMEY, M.D., CLEVELAND 957

XVIII. Neuromuscular Disorders Exclusive of Poliomyelitis. WINTHROP M. PHELPS, M.D., BALTIMORE, AND ROBERT A. KNIGHT, M.D., MEMPHIS, TENN..... 970